A REPORT ON
LOCATION AND DESIGN

INTERSTATE ROUTE 15

WOLF CREEK TO STICKNEY CREEK

STATE OF MONTANA

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A REPORT ON LOCATION AND DESIGN

INTERSTATE ROUTE 15

WOLF CREEK TO STICKNEY CREEK
MONTANA

OCTOBER 1961

PREPARED FOR

HIGHWAY COMMISSION
STATE OF MONTANA

WESTERN ENGINEERS & MORRISON-MAIERLE, INC.
CONSULTING ENGINEERS
HELENA, MONTANA

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MONTANA
HIGHWAY DEPARTMENT

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IN COOPERATION WITH

BUREAU OF PUBLIC ROADS
U. S. DEPARTMENT OF COMMERCE

WESTERN ENGINEERS & MORRISON - MAIERLE
ENGINEERS & CONSULTANTS
910 Helena Avenue, Helena, Montana

Octob[illegible]

Highway Commissi[illegible]
State of Montana
Helena, Montana

Gentlemen

We are pleased [illegible] submit th[illegible] preliminary engineering report on the location and de[illegible] of the propo[illegible] Inter[illegible] Highway Route [illegible] from Wolf Creek [illegible] This study conform[illegible] the Agreement [illegible] State Highway Commi[illegible] dated [illegible]

This report pre[illegible] recommen[illegible] [illegible] profile and traffic interchange[illegible] of the various Interstate Highway locations considered.

For each alternate, a complete analy[illegible] the cost, the service and the effect on local conditions and the ultimate highway plan. The report recommend[illegible] standards for the terrain encountered based [illegible] traf[illegible] studies and Interstate design criteria.

John J. Morrison

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ABBREVIATIONS

M.S.H.C.—Montana State Highway Commission

A.A.S.H.O.—American Association of State Highway Officials

D.H.V.—Design Hourly Volume

A.D.T.—Average Daily Traffic

c.f.s.—Cubic Feet Per Second

f.p.s.—Feet Per Second

DIVISION 3

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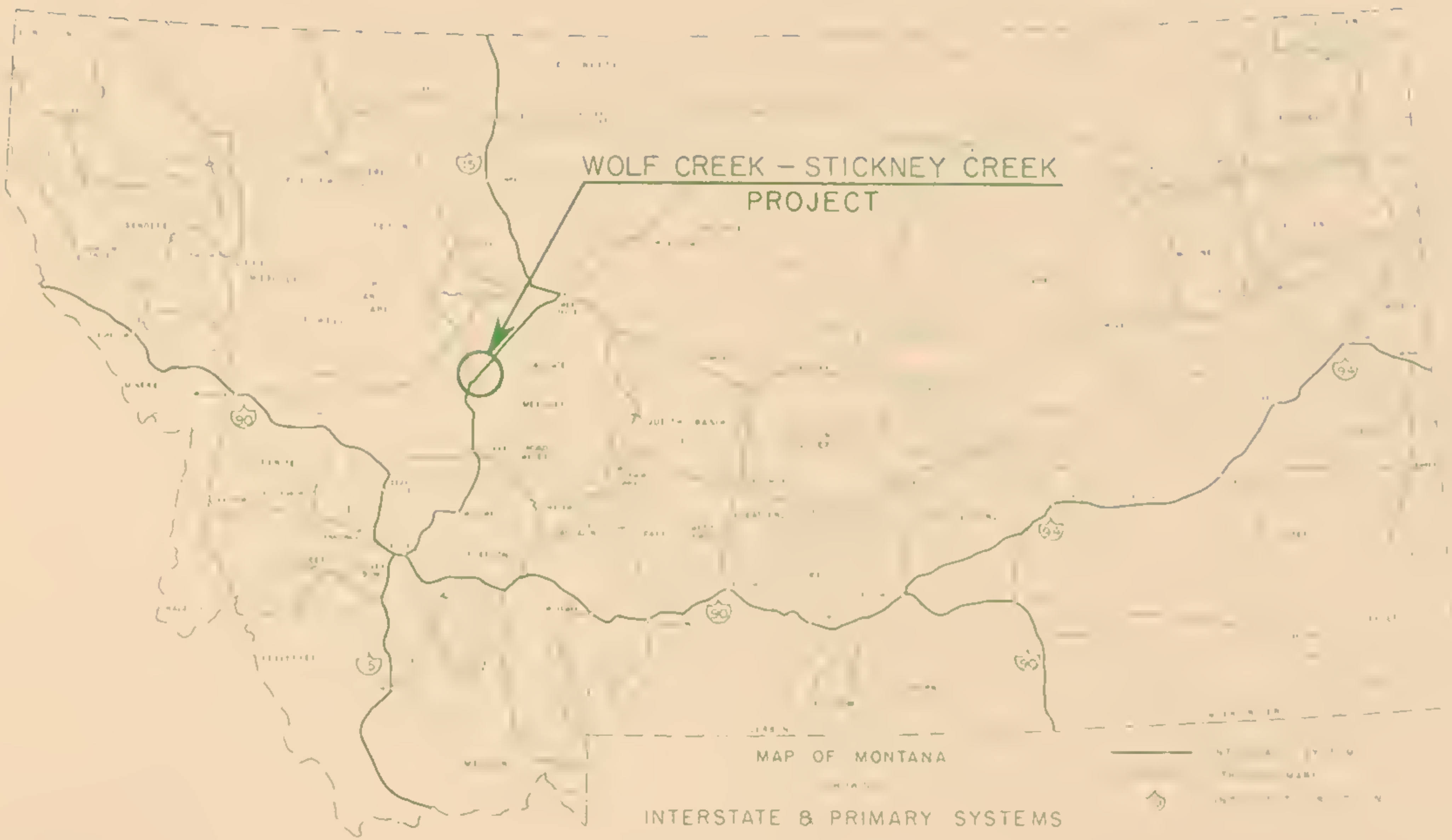
DIVISION I

REPORT

A REPORT ON LOCATION AND DESIGN
GEOLOGY
DESIGN STANDARDS AND CRITERIA
GEOMETRICS AND LOCATIONS
INTERCHANGES
HYDRAULICS AND DRAINAGE
MAJOR STRUCTURES
ECONOMIC ANALYSIS
MISCELLANEOUS CONSIDERATIONS
BASIS FOR COST ESTIMATES
CONSTRUCTION SECTIONS


WOLF CREEK – STICKNEY CREEK PROJECT
15
90
94
MAP OF MONTANA
INTERSTATE & PRIMARY SYSTEMS

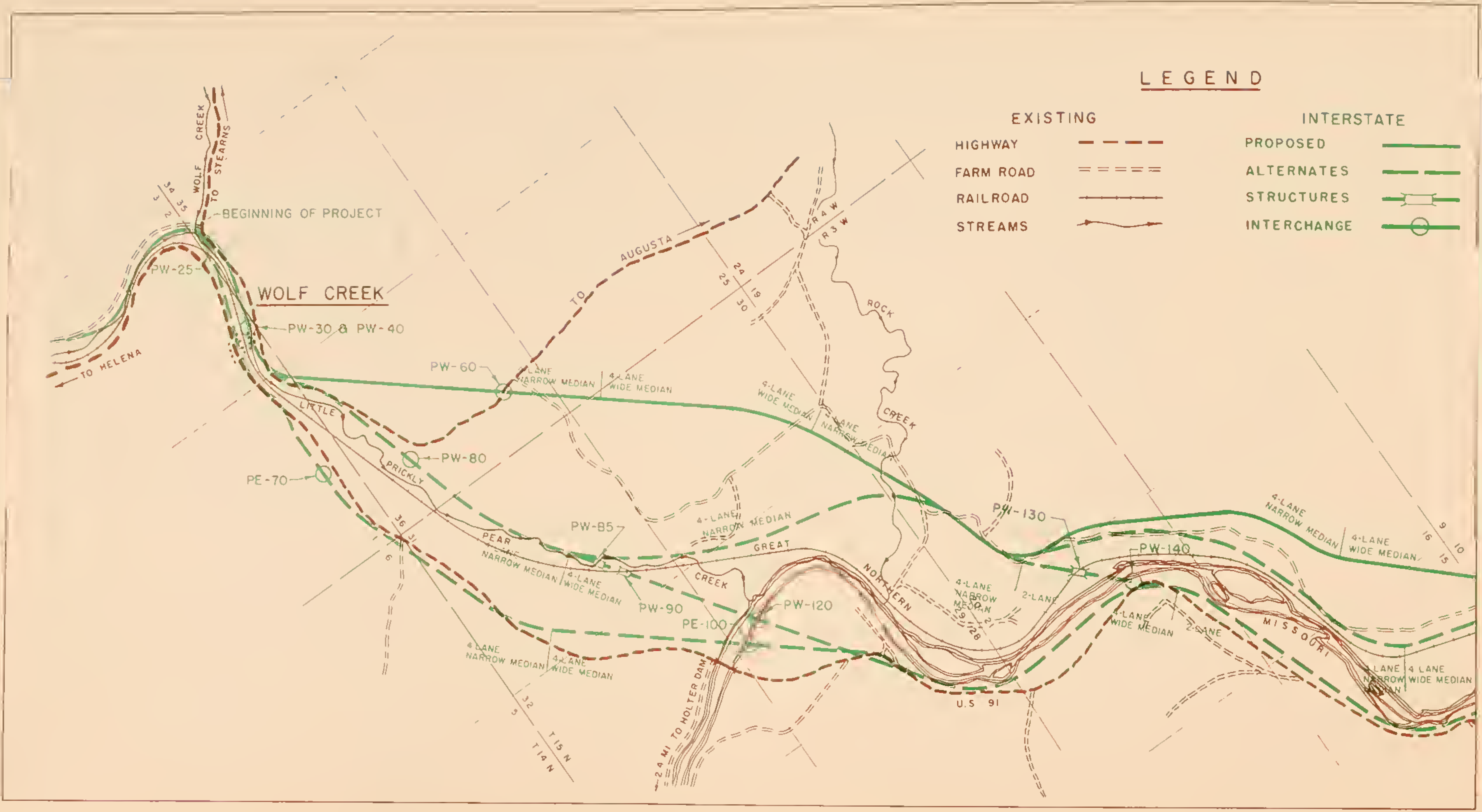
A Report On Location and Design

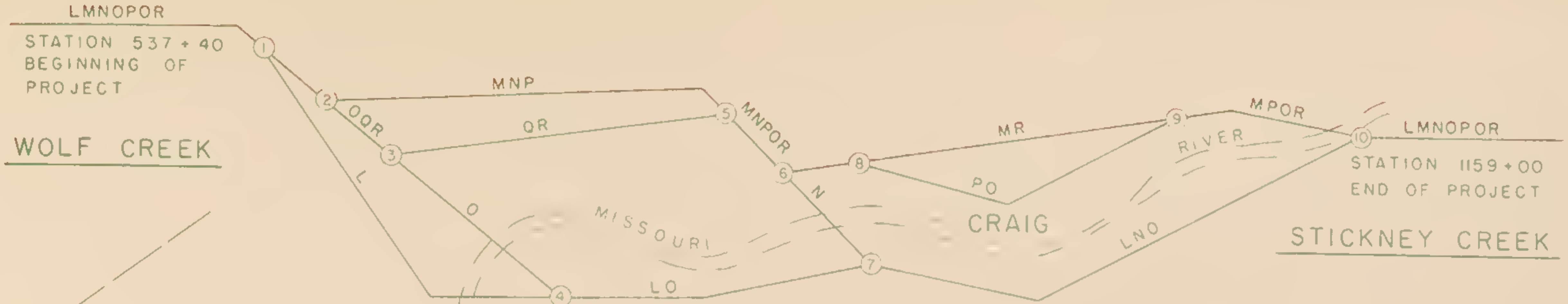
Foreword

The authorization for this report is an agreement between the State of Montana, acting through its Highway Commission, [illegible] Western Engineers and Morrison Maierle, Inc., Consulting Engineers. Interstate Route 15 enters southern Montana at Monida [illegible] through the cities of Butte, Helena and Great Falls and [illegible] boundary at Sweet Grass. The [illegible] tance from Helena to Great Falls in Lewis and Clark County [illegible] traverses a portion of moderately elevated mountainous [illegible] Missouri River Valley adjacent to the Big Belt Mountains.

The purpose of this report is to present the proposed recommended location for the Interstate Highway from [illegible] Town of Wolf Creek to Stickney Creek. Stickney Creek [illegible] three miles north of the Town of Craig, Montana. The proposed highway alignment, as reported herein, [illegible] alignment as reported to the Montana Highway Commission by Western Engineers and Morrison-Maierle, Inc. [illegible] May 7, [illegible] The [illegible] proposed in this report are [illegible] construction of the Montana Highway Department's Preliminary Engineering Project I [illegible] 2[illegible]

The information herein presented is the result of extensive engineering studies conducted by the Consultants [illegible] highway locations within or adjacent to the Little Prickly Pear Creek Canyon and the Missouri River Canyon. The study [illegible] the following items [illegible] all items [illegible]

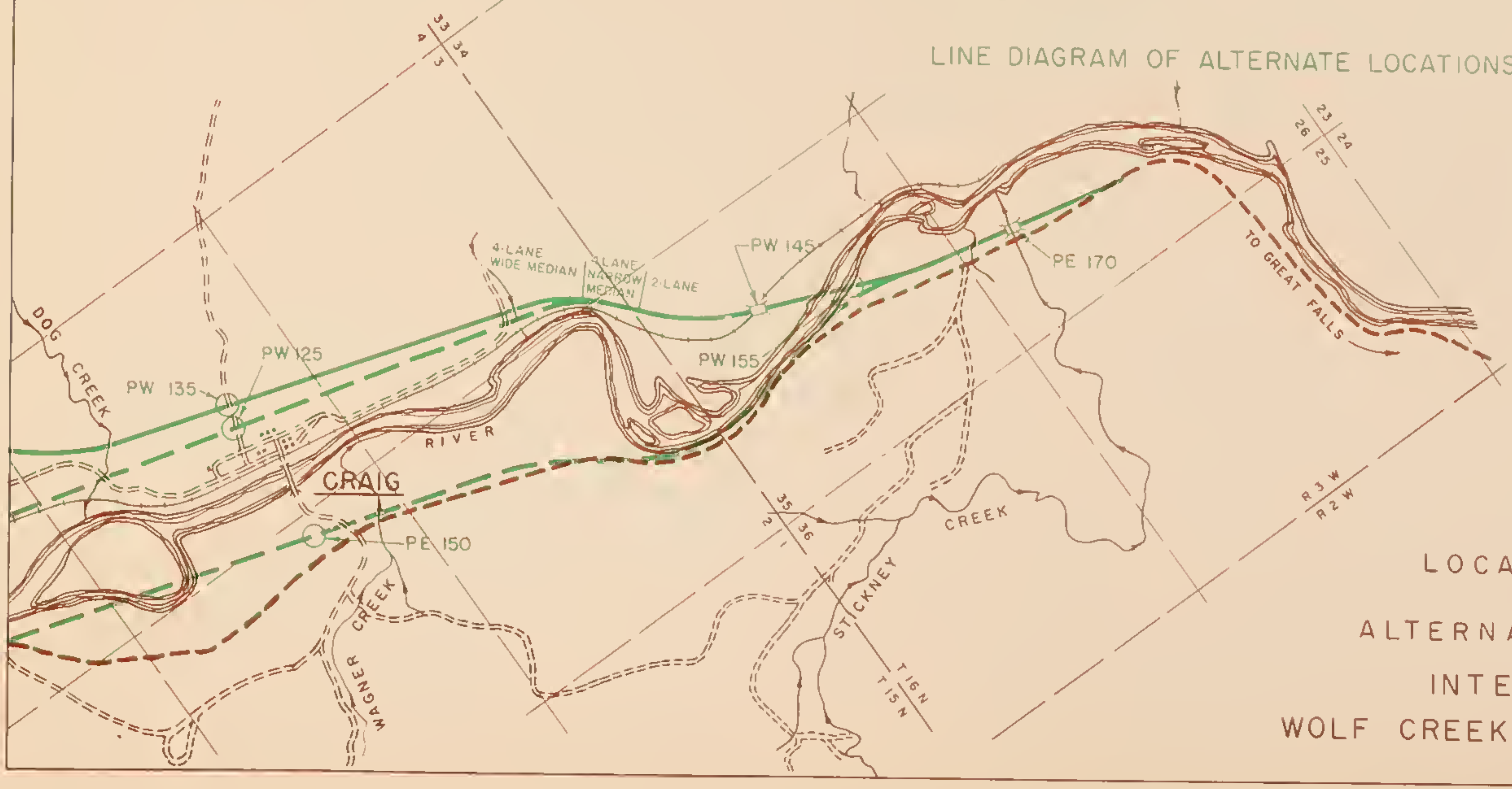

LEGEND
EXISTING
HIGHWAY
FARM ROAD
RAILROAD
STREAMS
INTERSTATE
PROPOSED
ALTERNATES
STRUCTURES
INTERCHANGE
WOLF CREEK
TO STEARNS
BEGINNING OF PROJECT
PW-25
PW-30 & PW-40
TO HELENA
TO AUGUSTA
PW-60
4-LANE NARROW MEDIAN
4-LANE WIDE MEDIAN
LITTLE PRICKLY PEAR CREEK
PW-80
PE-70
PW-85
PW-90
PW-120
PE-100
GREAT NORTHERN
ROCK CREEK
R 4 W
R 3 W
T 15 N
T 14 N
2-LANE
PW-130
PW-140
MISSOURI
U.S 91
2.4 MI TO HOLTER DAM
34 35
3 2
24 19
25 30
36 31
6
32
5
29 28
9 10
16 15



LINE DIAGRAM OF ALTERNATE LOCATIONS

EQUATION POINTS

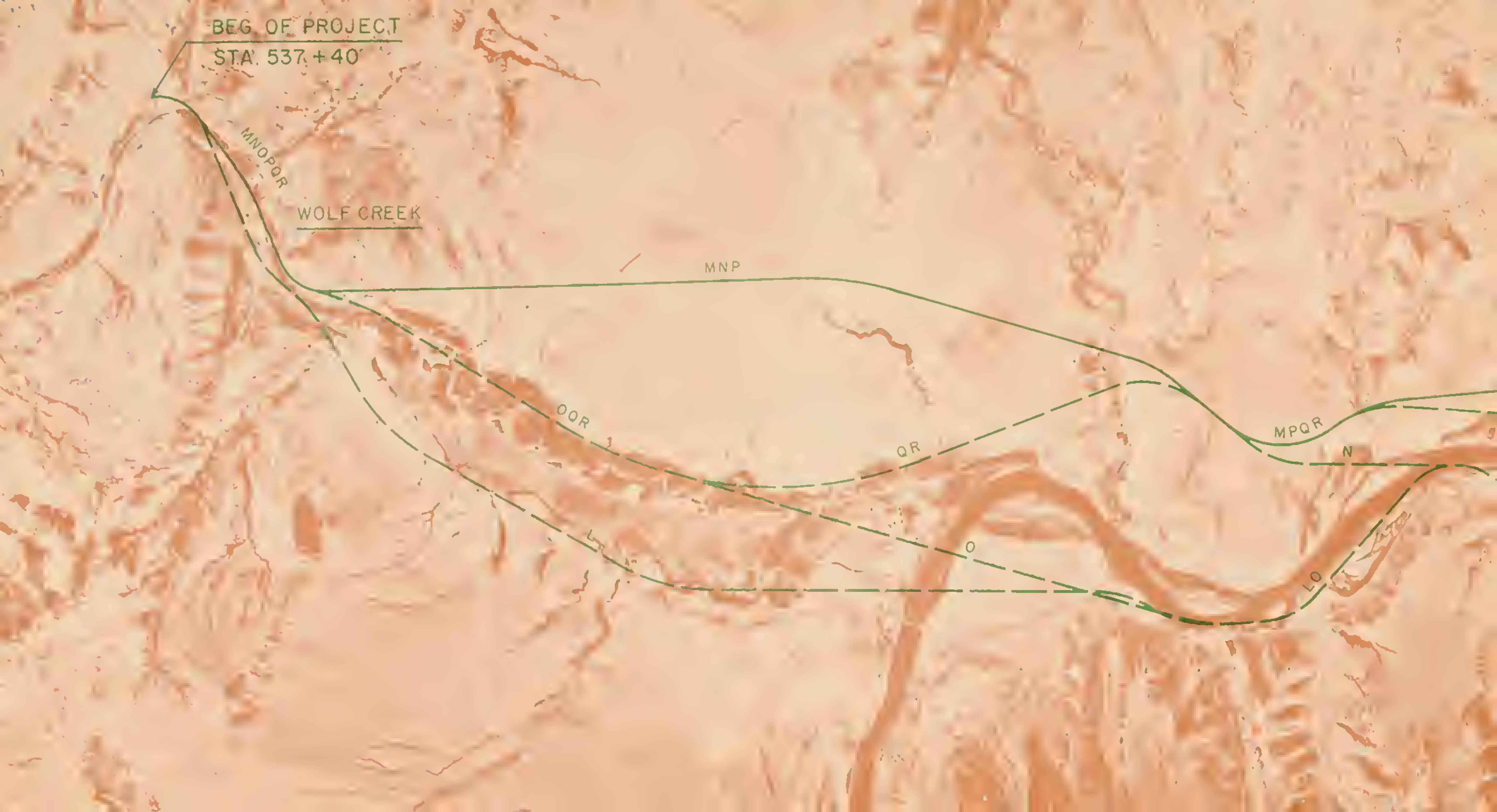
544 + 90 L = 544 + 90 MNOPQR
2 576 + 00 OQR = 576 + 00 MNP
3 655 + 00 QR = 655 + 00 O
4 784 + 52 O = 795 + 62 L
5 781 + 00 QR = 770 + 00 MNP
6 773 + 00 N = 773 + 00 MP
7 826 + N 852 + 76 L
8 775 + 00 PQ 775 + 00 MR
9 1034 + 25 PQ = 1019 + 52 MR
10 1094 + 65 MPQR 1140 + 00 NO

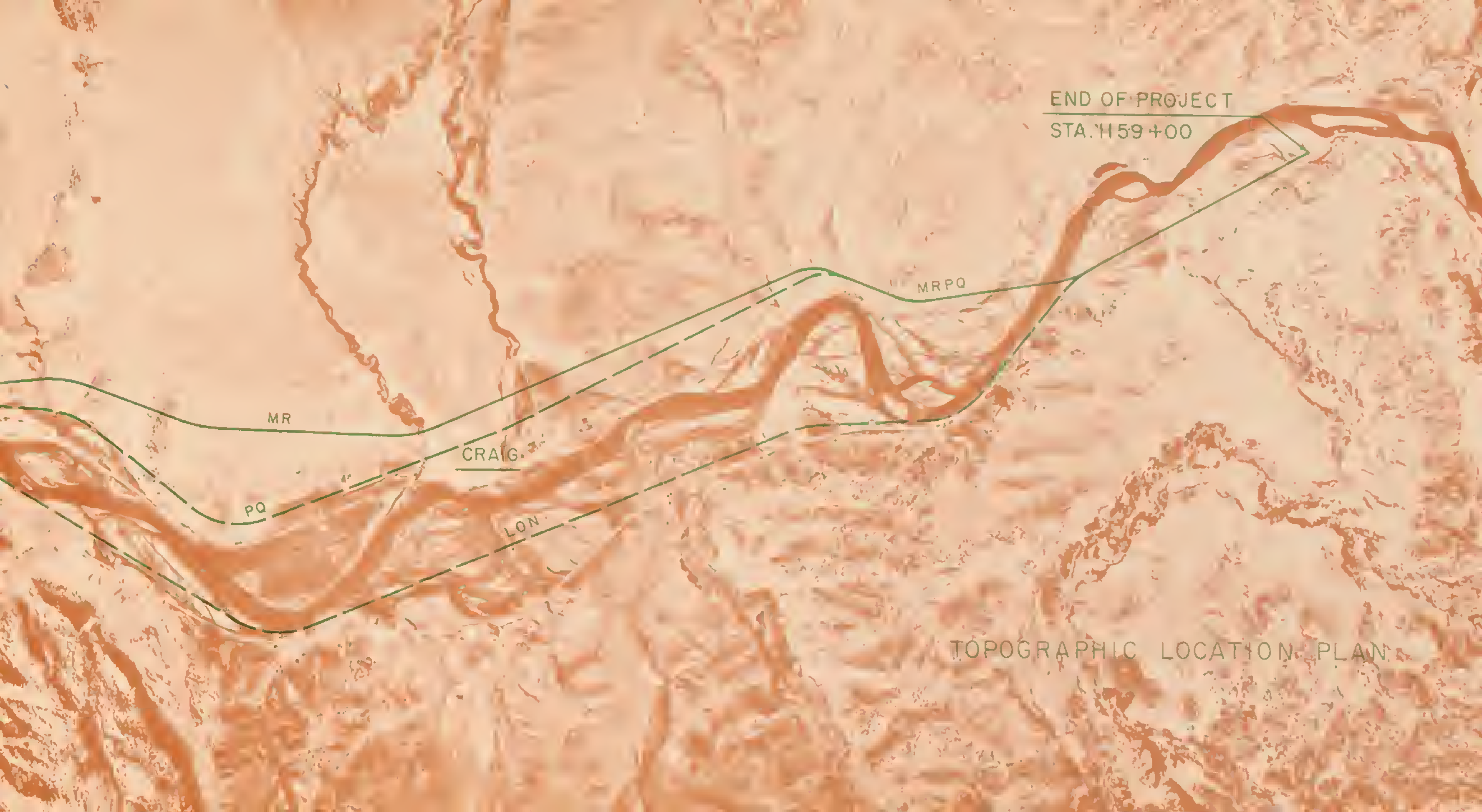


LOCATION PLAN OF ALTERNATES STUDIED

INTERSTATE 15

WOLF CREEK TO STICKNEY CREEK


BEG. OF PROJECT
STA. 537+40
MNOPQR
WOLF CREEK
MNP
OQR
QR
MPQR
N
L
O
LO


TOPOGRAPHIC LOCATION PLAN

1. Geometrics
2. Soils and Geology
3. Hydraulics
4. Bridges
5. Interchanges
6. Relocations
7. Design Standards
8. Construction Cost Estimates
9. Economic Analysis
10. Construction Sections

In order to avoid the expense of duplication of effort, all pertinent available data of the Montana Highway Department was used whenever possible.

A public hearing on the location of Interstate 15 from Wolf Creek to Stickney Creek was held in Craig on Sept. 19, 1961. The recommended alignment contained in this report was presented at that time as well as the other alternates studied.

Explanation of Key Plan

The map entitled "Location Plan of Alternates Studied" on pages 2 and 3 of the Report serves as a key plan drawing to show the lines or locations which were studied in detail and to show their relationship to each other and to other features in the vicinity. Line Alternate L is along what is termed as the east side of the Missouri River, and Alternates M and Q are along the west side of the Missouri River. Line Alternate Q was the alignment used for the initial Montana Interstate studies for cost proposals to the United States Bureau of Public Roads and identified by the Montana Highway Department as Estimates 108(d) of date July, 1957 and 104(b) of date August, 1960. The other Alternate Lines, N, O, P and R, are composed of combinations of segments of the L, M and Q lines plus the additional segment to cross from one of the initial alignments to another.

For ease of reference, and in order to clarify the interrelationship of the various lines, a line diagram is shown on the same drawing. The configuration of any one complete alternate, such as Alternate N, can be traced on the line diagram by following the line labeled N from the left side of the diagram labeled Beginning of Project to the right side labeled End of Project. A mental transposition of this configuration to the key plan will then indicate Alternate N on the key plan. The southern end of the area studied is designated as the Beginning of the Project.

The stationing at the Beginning of the Project is 537+40, and is sequential on Alternate L to 1159+00. The other alternates are sequential from where they separate from the Alternate L and equate where they rejoin Alternate L or each other. Stationing of all lines was extended to a common terminal point of intersection north of Stickney Creek.

Summary of Recommendations and Costs

It is recommended that the alignment designated and detailed as Alternate M in this report be accepted as the proper location to be designed and constructed for Interstate Route 15 from Wolf Creek to Stickney Creek. Facts, figures and illustrations contained in this report will substantiate this recommendation as sound.

This location is the most acceptable of all alternates investigated because:

1. It is the shortest route.
2. It provides the best service to Wolf Creek through a full interchange in town.
3. It provides the best service to Craig and the old Craig bridge, which is inadequate, will not have to be depended on.
4. It has the highest cost benefit ratio and the least annual cost expenditure.
5. It has the greatest safety features.
6. The present highway will be retained as mileage of road rather than lost due to new construction in the same vicinity.
7. It has the best service to the users of the Augusta primary highway.
8. It has the greatest percentage of 4-lane mileage and the most 4-lane wide median.
9. The land required for right-of-way is of a lesser productive nature.
10. There will be no disturbance of the Missouri River and present access to the river will be retained for ranchers and sportsmen.
11. Access problems to lands adjacent to this alignment are fewer and of less consequence.
12. No at-grade approaches are required.
13. It has the second lowest angular deflection of all proposed lines.

Based on traffic counts made in 1958 and projected to the year 1975 by the Montana Highway Department, it has been determined and justifications will be presented for initial construction of four lanes throughout all but the last mile and one-half of the highway involved in this study.

From the Beginning of Project to a point just beyond the Augusta road interchange, the highway will be a four-lane narrow median section with an eight-foot wide flush median with double rail barrier guard rail. At this point there will be a transition to a four-lane wide median section. The four-lane wide median section will continue to Rock Creek where it will again transition into a four-lane narrow median section. This section will continue for about two miles, then once more transition into a four-lane wide median section, which will continue to and beyond Craig. Then, with a transition into a narrow median section, and shortly followed by a transition into two-lane, the highway will cross the Missouri River and continue to Stickney Creek which is the End of the Project.

The proposed alignment is portrayed in detail on Plan-Profile Figures 1 through 21. The maximum grade is 5%. Two curves at Wolf Creek will necessitate a 6 degree curvature. Throughout the remainder of the proposed alignment, the maximum curvature is 3 degrees. Transition spirals are used on all curves over 1½ degrees. The minimum stopping sight distance is 600 feet on crest vertical curves. Design speed is 60 miles per hour on the Interstate roadway north of Wolf Creek and interchange ramps will safely accommodate traffic with an exit or entrance speed corresponding to the design speed of the Interstate at their respective locations.

Four interchanges are recommended and the preliminary layouts provide for desirability, adaptability and attainability. The Wolf Creek and Craig interchanges are a full diamond type. The Augusta road intersection with the Interstate roadway employs a trumpet interchange to attain a no-stop condition between the primary highway and the Interstate. A half-diamond interchange at the north end of the Missouri River bridge will adequately serve this immediate area and the areas along the east side of the river and allows the use of the structure over the river to be used as the interchange overpass.

Cost Estimate of Location Alternate M.

Grading	$2,597,688	
Surfacing	1,150,990	
Major Structures	1,255,000	
Other Construction	951,547	
SUBTOTAL		$5,955,225
Construction Engineering and Contingencies (10%)	595,523	
Utility Relocations	59,000	
Right of Way	301,901	
TOTAL COST		$6,911,649

Historical Background

The history of the route south of the town of Wolf Creek was published in a previous report to the Montana Highway Commission. The route north of Wolf Creek through the Missouri River Valley has a less colorful history.

Before the construction of the Montana Central Railway through the valley, travel into areas of the valley was difficult and to some areas there was no access. The railroad facilitated shipping of livestock and produce, thereby increasing the effective value of the land. Rural roads were constructed and before the 1920's a road was passable from Wolf Creek to Cascade. Travel had previously gone north from Wolf Creek and then east to reach Cascade. The town of Craig was a freight stop on the railroad located at the ranch site of the family of Creag.

In 1916 the Federal Government passed a law offering monetary construction assistance to each state and in 1921 a law was passed allowing this assistance to be applied to 7% of each state's mileage. Shortly thereafter, the road traversing the Missouri River Valley from Wolf Creek to Cascade was proposed as a Federal Aid Highway. However, actual construction was not begun until 1935. This highway has served to this day, and due credit should be given to those who located, designed and constructed this highway.

Geology Report

This geological reconnaissance study includes the multi-terraced Missouri River Valley from the town of Wolf Creek north to the confluence of Stickney Creek and the Missouri River. Within these limits numerous tributaries empty into the main channel. Wolf Creek and Little Prickly Pear Creek join and enter from the south. Rock Creek and Dog Creek enter from the west and Wagner Creek and Stickney Creek drain from the east.

The topography of the area is typical of mature river valleys. Alluvial fans from high mountain ranges form the transition to the stepped erosional river terraces above the valley floor. The wide valley contains the meandering river which flows on deep flood plain sediments. The four terraces in this area represent different stages of down-cutting in the river's complex history. The highest terrace, located approximately one-half mile east of the town of Wolf Creek on the north side of the valley, occupies an elevation of 3,875 feet, approximately 400 feet above the present valley.

The reconnaissance study was initiated in this area to aid in the location of the most feasible highway location, both geologically and economically. The extreme complexity of the geology prohibits mapping of the myriad of faults, folding, and the changes in dip and strike of bedding. In keeping with the purpose and scope of this report, all geologic data pertinent to preliminary road design is included.

Aerial photos (scale, one inch equals 1,000 feet) were used in the field and major geologic boundaries were placed on these photos. This information, transferred to U.S G.S. topographic maps (scale; one inch equals 1,500 feet) is entered as Figure 24 and 25 in this report.

One of the most complex geologic phenomenon in western United States, the Montana Disturbed Belt, trends north-westerly across the area under study. Beds of sandstone, shale, claystone and siltstone have been buckled and thrust over one another, repeated by faulting, and intruded by massive volcanics. The United States Geologic Survey has begun a detailed mapping program of this area in order to gain a better understanding of the vast structural deformation. The general regional trend is approximately forty degrees west of north. Faults and thrusts follow this trend and dip to the southwest. The thrusts dip from 35 degrees to 50 degrees and the bedding planes reach steeper angles in some areas. The Missouri River has cut a channel normal to this regional trend and exposes some of the complex folding and thrusting on steep canyon walls south of Craig.

Geologic History of the Wolf Creek-Stickney Creek Area

Climaxing a major portion of geologic time, during which oceans transgressed and regressed and erosion processes were active, the Laramide Revolution affected the last major crustal change in Montana. The Disturbed Belt, whose front also forms the eastern Rocky Mountain chain, trends north-westerly across the area included in the report. A complex consisting of low angle thrust faults, high and low angle reverse faults, and normal faults, separates this portion of the state from the less disturbed geology of eastern Montana. As a result of these dynamic forces, the nearly flat-lying sediments assumed their present warped and steeply dipping attitude. As the forces relaxed, normal faulting occurred and volcanic activity lent to the complexity. Streams which flowed to the south were dammed and overflowed higher mountain divides, causing reversals of drainage. During the Pleistocene glacial ages a great portion of the present Missouri River Valley was covered by standing water as evidenced by lake bed sediments many tens of feet thick. Following the drainage of these lakes, erosion processes began shaping the numerous land forms which exist today.

South of Craig the largest overthrust occurs at the contact of the Adel Mountain volcanics and beds of sandstone, shales and clays of older Cretaceous Age. The Adels are believed to be the cause of the complex structures in this area. The Laramide forces caused the beds to be forced against the resistant Adel volcanics. The weaker beds buckled and broke along their anticlinal axis and began overriding the younger volcanics.

General Relationships of Geology to Engineering Design

Because of the northwest trend of the regional geology and the general northeast direction of the proposed highway, a favorable condition exists since the highway cuts will generally be normal to the strike of the beds. Where resistant beds are encountered, cuts should stand well within interstate design standards.

A great amount of construction will be on recent alluvium, terrace gravels and recent flood plain sediments. These types of materials should be relatively free draining, and the gravels are readily available throughout the project for subgrade material.

The variable depth of the Missouri River sediments pose a problem with regard to bridge design. The existing Missouri River bridge at Wolf Creek has both abutments placed on bedrock. However, a test hole drilled 1,200 feet downstream, approximately on Alternate "O" centerline, indicates bedrock at a depth of 75 feet. Testing for a proposed damsite east of Cascade revealed 270 feet of river sediments overlying bedrock. In this area, as well as other areas where structures are required and outcrops do not occur, a thorough testing program should be initiated to insure proper final design.

Slope stability on sidehill cuts, kind of materials to be excavated and problems unique to particular sections of the highway will be discussed in another section of this report.

Explanation and Key to Geology Map

The general Geology Map entered as Figure 24 and 25 is the result of field reconnaissance and aerial photo interpretation. The boundaries are in keeping with the mapping scale and preliminary investigation. Rock units, where outcropping uniformly, are given their proper symbols.

Where multiple units are repeated by faulting and folding they are given a general symbol (CJKu) to keep the overall map less complex, and to retain its general purpose. Scores of faults are in evidence and at least nine overthrust faults have been encountered in the area. However, only a very few are prominent enough to be mapped. None are believed to have any effect on the highway design.

Dashed line shading indicates rock of volcanic origin and includes volcanic intrusives and sedimentary beds.

Solid line shading represents non-volcanic rock of sedimentary origin and includes shales, sandstones, siltstones, claystones, and limestones.

Heavy stippling indicates terrace gravels or gravels of alluvial origin.

Varied clays and silts of glacial origin, considered to be lake bed sediments, are indicated by lighter stippling.

Areas where no definite marks appear should be interpreted as having alluvium to considerable depths. However, the alluvium undoubtedly covers areas where bedrock closely approaches the surface.

Geologic Analysis of Location "M"

A. Station 537 to Station 665

Within the above limits the proposed line will rise in a northeast direction from the valley floor in the town of Wolf Creek to the wide, alluvium covered, third river terrace. From Station 537 to 577 the alignment will traverse river sediments composed chiefly of clays and silts. Drilling in this area indicates approximately 90 feet of material overlying bedrock. At Station 577 to 590 extremely resistant crystalline rhyo-dacite rock will be encountered. This flow rock has been injected as a huge sill between less resistant sediments. In the Wolf Creek area these flows represent a thickness of over 4,000 feet. This rock should stand easily at ¼:1 and the inherent columnar jointing pattern should aid in its removal. From Station 590 to 620 the line will pass from high fill to alternate cut and fill. Extremely fissile shales of the Colorado formation will be encountered. The strike of these dark carbonaceous shales is normal to the alignment and their dip is approximately 30 degrees. Because of their extreme fissility, slopes will weather and small fan-like deposits may build up at their base. Cut slopes of 1½:1 are recommended in these shales. From Station 620 to 665 cuts will encounter repeated sandstone beds 3 to 4 feet in thickness interbedded with the aforementioned fissile shales. Again, cut slopes will weather in the weaker shales and proper design would require 1½:1 slopes. The shale and thin sandstone beds should be easily removed by common ripping equipment.

B. Station 665 to Station 755

Between the above stations the proposed line will cross the third river terrace which is composed chiefly of alluvium derived from the mountain front and underlain by gravels, silts and sands of fluvial origin.

Field examinations of these silts indicate that they lack any cohesive strength when saturated. It is strongly recommended that proper testing of these materials be initiated prior to final design. A large cut from Station 725 to 745 is not expected to encounter any bedrock. However, it should be recognized that the deposition of lake bed clays and silts, fluvial clays and silts, and alluvium represents the final stage of erosion in this area and that projections of bedrock may be encountered at varying depths throughout the project.

C. Station 755 to Station 855

Within these limits the geology becomes extremely complex. Beds are often repeated by faulting and or folding. Because of this repetition, these beds, representing rock of Carboniferous-Jurassic-Cretaceous Age, are grouped together and given the general symbol of CJKu on the Geology Map. From Station 755 to 775 units of sandstone, some over 100 feet thick, will be encountered. Interbedded with these sandstones are beds of less resistant shales, claystones and siltstones. This same condition exists through Station 790 with the sandstone beds being replaced by limestone of lesser thickness. Wherever cuts exceed 15 feet it may be expected that beds of sandstone and limestone may be encountered and blasting methods will be required for removal. From Station 780 the alignment descends to the valley floor passing through glacial lake beds at Station 800 and then into alluvium material of local derivation. The shallow cuts should not reach bedrock through Station 855.

D Station 855 to End of Project

In the proximity of Station 855 the line traverses the Craig Overthrust Zone. Here, folded beds of limestone and sandstone have been forced against nearly flat lying beds of the Adel Mountain volcanics. The extreme warping and folding may be seen on the high walls above the valley floor. From Station 855 to 880 highway cuts will be in resistant sandstones and volcanics. The volcanics are mostly conglomeritic. Boulders ranging in size from a few inches to a few feet have been noted. The unit is well cemented and extremely resistant, excavation in this material will be difficult. Some well cemented sand lenses have been noted interbedded with the conglomerates. In the vicinity of Craig, lake bed silts and clays reach considerable thickness. These lacustrine deposits of glacial age appear to lie in pockets of Adel volcanic rock. The thickness of these beds is extremely variable and it may be expected that bedrock will approach the surface intermittently in this area. From Station 1,000 to End of Project all cuts will be in the above mentioned Adel volcanics.

Design Standards and Criteria

Design criteria are based on those acceptable for the Interstate system. This is outlined in the pamphlet entitled "Geometric Design Standards for the National System of Interstate and Defense Highways" adopted by the American Association of State Highway Officials (A.A.S.H.O.) and the U. S. Department of Commerce, Bureau of Public Roads. This is the criteria used on Interstate highways throughout the nation which involve the use of Federal Aid funds. Incorporated as design guides are the book publications of A.A.S.H.O. "Policy on Geometric Design of Rural Highways," "Policy on Arterial Highways in Urban Areas," and "Standard Specifications for Highway Bridges." The "Field and Office Standards" and "Standard Drawings" publications along with other current written standard practices of the Montana Highway Department are also used as guidelines.

Determination of Number of Lanes

1. Design Conditions
   (1) Type of terrain—Rolling
   (2) Design speed—60 MPH
   (3) Traffic Lane Width—12 feet
   (4) Traffic Data (From Montana Highway Commission Planning Survey)

	Wolf Creek South	Wolf Creek North
DHV 1975	130	360
Commercial Vehicles	12% DHV	12% DHV

2. Design Criteria:

   Reference: Geometric Design Standards for the National System of Interstate and Defense Highways.
   Paragraph: "General"
   Reference: Policy on Geometric Design of Rural Highways
   Paragraph: "Capacity" page 84, page 85 and page 5
   Reference: The Highway Capacity Manual (Recommended as a guide for design.)

3. Check 2-Lane Highway for Design Capacity Using Highway Capacity Manual as Design Guide.

   Lanes 2—12 feet.
   Shoulders 10 feet (Unrestricted lateral clearance)
   Design Capacity and Practical Capacity are the same value. (Reference: Highway Capacity Manual page 8 and Policy on Geometric Design, page 85 and page 636, paragraph "Design Capacity.")
   Practical Capacity: 600 passenger cars per hour for operating speeds over 50 MPH. (Reference: Table 5, page 52; and paragraph "Two Lane Roads," page 46, Highway Capacity Manual.)

The reference for verification of operating speeds in the 50 to 55 MPH range for this project is the Special Accident Study undertaken several years ago by the Planning Survey section of the Montana Highway Department for the portion of U.S. 91 from 8 miles north of Helena to Cascade. The results of this study reveal that the average speed of vehicles, including trucks on this section of present highway from Wolf Creek to Stickney Creek, is over 50 MPH. With construction of a higher type facility the corresponding average speed will not decrease and in all probability will increase to some extent.

Conditions which affect the practical capacity of a 2-lane highway are: (1) lane width, (2) shoulder width, (3) commercial vehicles, (4) the profile and alignment, especially as related to sight distant and gradient, (5) location and design of interchange facilities, and (6) clearance to lateral obstructions. (Reference: Highway Capacity Manual, page 8). Since 12-foot lanes with 10 foot shoulders are ideal conditions, the first two conditions will not affect practical capacity.

Adjustment for Commercial Vehicles 67%.

(Reference: Table 9, page 56 of the Highway Capacity Manual, interpolate for 12% trucks in rolling terrain. The adjustment for the effect of commercial vehicles on practical capacities of multilane facilities interpolated from Table 9 is 0.74. Page 57 of the Highway Capacity Manual also provides that "On two-lane highways the effect of commercial vehicles is about 25 per cent greater than on multilane expressways." This reduces the adjustment for commercial vehicles to 0.67.)

0.67 600=402 vehicles per hour.

Adjustment for Alignment and Curvature.

The practical capacity is greatly affected by the alignment and profile and this effect can be determined by the percentage of restricted sight distance. The Highway Capacity Manual recommends a minimum sight distance to the road surface of 1,500 feet be used as a criterion of the highway's practical capacity. The recommended range in the manual for this value is from 1,500 to 2,000 feet. The length of 1,500 feet was used in this evaluation and is, therefore, on the conservative side. The sight distance value is not related to the safe passing sight distance for design speed, but is selected for purposes of evaluating design capacity on 2-lane highways. The following paragraphs show 2-lane design capacity on locations proposed for 4-lane to indicate the inadequacy of a 2-lane section in these areas.

The total sight restriction of Alternate M, on the northwest side of the Missouri River, is 49 percent. With this alignment divided into the proposed 4-lane and 2-lane sections recommended in this report and considered separately, the restriction is 51 percent on the 4-lane section and 12 per cent on the 2-lane section. An estimate of 40 per cent restriction would be considered conservative for a section proposed for 4-lane on any studied location on the northwest side of the Missouri River.

A detailed study of the proposed Alternate L showed that the restricted sight distance for the total length is 44 per cent. Dividing the line into two sections in order to investigate the first section for justification of 4-lane, indicates that the sight restriction in the proposed 4-lane section is 52 per cent. A study of Alternate O revealed that the total length of that line is restricted 38 per cent and the proposed 4-lane section is restricted 40 per cent.

All proposed sections of 4-lane have a restriction of 40 per cent or greater and the practical capacity will be determined using a 40 per cent sight restriction. Restrictions that were not considered, are on passing areas at interchange ramps on a 2-lane highway and lateral clearance restrictions. The 2-foot lateral clearances on the long structures would affect the reduction of practical capacity less than one per cent. The effect of commercial vehicles has been considered for general conditions but not for individual grade lengths and rates which would reduce the practical capacity. Table 11, page 58 of the Highway Capacity Manual shows a reduction to 83 per cent of practical capacity for operating speeds of 50 to 55 MPH where 40 per cent restriction occurs. Therefore: 0.83 × 402 = 334 vehicles per hour.

This figure is below the 360 DHV. In order to comply with the directive in the pamphlet on Standards for Interstate and Defense Highways, which states that "unquestioned adequacy should be the criterion," a two-lane facility for the 1975 DHV is not acceptable and four lanes will be required as indicated on proposed locations

Additional Design Data for Interstate

The design conditions used as stated at the beginning of this section were determined in consideration of the terrain. The pamphlet by A.A.S.H.O. entitled "Geometric Design Standards for the National System of Interstate and Defense Highways" states that "The design speed of all highways on the system shall be at least 70, 60, and 50 miles per hour for flat, rolling and mountainous topography, respectively, and depending upon the nature of terrain and development." The Arizona Highway Department defines these terms as follows:

Flat topography. Cuts and fills up to 10 feet are common. Grades of 3 per cent or less can be obtained without affecting alignment appreciably.

Rolling topography. Cuts and fills up to 80 feet are called for. Short runs of maximum grades.

Mountainous topography: Terrain with precipitous canyons and escarpments. Extended maximum grades required.

The horizontal alignment of all alternates northeast of Wolf Creek has a maximum curvature of 3 degrees which would be more than adequate for 60 MPH design. A study of these lines showed that increasing the degree of curvature on any location would not decrease costs to any appreciable extent. Therefore, a transition of design speeds, in relation to horizontal alignment, from 50 MPH to 60 MPH occurs directly northeast of the town of Wolf Creek on all locations.

The pamphlet by A.A.S.H.O. mentioned above states that: "For design speeds of 60 miles per hour gradients generally shall not be steeper than 4 per cent." Grades of 5 per cent were used, despite the fact that a design speed of 60 MPH generally dictates a grade of 4 per cent for reasons of economics and the small percentage of this grade. If 4 per cent grades were used the sight restrictions would limit the practical capacity to the extent that 4-lanes would still be required. A 4-lane highway provides a climbing lane for trucks and thus the free movement of passenger cars would not be hindered. This would guarantee against any future obsolescence of this highway resulting from an unexpected increase in the predicted traffic for 1975.

A study of Alternate M which is typical of all gradients on the northwest side, showed that only 17 per cent of its total length contained 5 per cent grades. The 5 per cent grades were in six separate sections, three of which averaged 1,000 feet, two averaged 2,000 feet and one was 3,000 feet long. The majority of these grades have a downgrade approach and the permissible speed reduction for trucks of 15 MPH can be increased 5 to 10 MPH being dependent on the length and steepness of the downgrade. The critical length of grade for an average loaded truck ranges from 800 to 1,550 feet depending upon the permissible speed reduction from 15 MPH to 25 MPH. The three 1,000 foot grades are approached by downgrades and will not cause an unreasonable reduction in speed. There are only two sections in either the north bound or south bound direction that have lengths which are approximately 2,000 feet longer than the critical length. The effect of these grades would not be appreciable on passenger cars and the time lost for trucks would be more than offset by the distance saved on this location. These grades may be improved during the final design stages through slight line shifts and grade revisions.

A considerable savings can be shown by using a shorter amount of 5 per cent grade instead of a longer amount of 4 per cent grade. With a 4-lane highway providing climbing lanes for commercial vehicles and no restrictions on passenger vehicles this design is still 60 MPH.

The alternates on the southeast side of the Missouri River follow the river closely enough to where maximum grades of about 3 per cent can be obtained with an average gradient of about 1 per cent. Alternate 1 has one short grade of 3.6 per cent which is in the Wolf Creek area and could be considered as in the transition from 50 MPH to 60 MPH design.

The stopping sight distance attained is 600 feet. The allowable by standards is 475 feet. Vertical curve lengths are based on 150 times and 250 times the algebraic difference of grades expressed in per cent for sag and crest vertical curves, respectively. Lane widths on all lanes, for either 2-lane or 4-lane sections, are 12 feet. Median widths are 8 and 16 feet for narrow median and wide median sections, respectively. The outer shoulder widths are 6 and 10 feet for narrow median and wide median sections respectively. Portions of the northwest side of the Missouri River are more rugged than strictly rolling terrain and in the interest of economics, narrower medians were used. A 2-lane highway would be inadequate because of the practical capacity, but a 4-lane wide median highway is more than required for predicted traffic of 1975. Therefore, the use of narrow medians in more expensive construction areas is justified. If at a future date the traffic increase should warrant a higher type design, the median could be widened to 16 feet and 10 foot outside shoulders used. This change would not require a radical change in the roadway section but would be strictly a widening process. Due to the high capacity of a 4-lane section as compared to the future traffic in this area, 6 foot outside shoulders were used, which would not be detrimental to the safety of this highway.

Spiral transitions are used at both ends of all horizontal curves sharper than one and one-half degrees. The rate of superelevation will not exceed 0.08 feet per foot. This is based on consideration of these factors: climatic conditions, terrain, type of area and frequency of slow-moving vehicles. Transition to full superelevation will occur within the spirals or in a runoff distance beyond the beginning and end of curves without spirals.

Ramp design was predicated on the Interstate design speed at the nose. Adequate length and curvature was allowed for acceleration to this speed for access to the Interstate and for deceleration to a stop condition at the crossroads.

Standards for dimensions, excavation and embankment slopes, and surfacing thicknesses are shown on Figures 22 and 23. Criteria for design of structures are discussed under the section on Major Structures. Information pertinent to small drainage structures will be found under the section on Hydraulics and Drainage.

Geometrics and Locations

General

As has been mentioned in the Geology section of this report, the river valley contains four terraces. However, only one is very expansive. This terrace is the plain on the northwest side of the Missouri River and approximately 100 feet higher in elevation. The controlling natural features within this valley are the Missouri River and the precipitous slopes to the east. As discussed in the Geological Section of this report, there are plates of rock protruding from the ground perpendicular to the river. Those rock areas will be traversed on all studied lines and do not greatly effect the choice of the proposed highway location.

The preliminary evaluation of prospective locations on the site and on topographic maps resulted in the decision to study in detail the alignments shown on pages 2 and 3, and discussed under the report section entitled "Explanation of Key Plan." Considering each alternate separately, cost estimates for a total of 56 miles of alignment were computed and tabulated. This was the result of detailed study and an estimate of quantities for 34 miles of separate, distinct and unduplicated lines. The same extent of detailed consideration regarding grades, cross sections, curves, drainage structures, etc., was accorded all alternates, L through R.

The sequence used for line study and evaluation follows. Alignments were located on contour maps obtained from the Montana State Highway Department. Contours on the maps were at 5-foot intervals except where steep slopes required intervals of 20 or 25 feet. The scale of the maps were 1 inch equals 200 feet. Ground line profiles and cross-sections were plotted from these maps. Cross-sections in rocky areas or areas of heavy construction work were at intervals of 100 feet or less. Most other cross-sections do not exceed several hundred feet between sections. Grades were laid and earthwork quantities were computed. The visual pictures of the cross-sections were extremely valuable for determining locations and estimating quantities.

Except for two 6 degree curves in the town of Wolf Creek it was possible to locate all lines without exceeding three degree horizontal curvature. The use of sharper curves would not materially reduce the construction cost commensurate with the detriment to the safety of the road user.

A consideration that favors the location of any of the alternates lying on the northwest side of the Missouri River is the possibility of retaining as much as possible of the existing highway for access and frontage road purposes. This becomes an important item when related to the cost of maintenance of traffic during construction, if an existing road can be used for this purpose.

The following discussion of alternate routes is based on two locations through the town of Wolf Creek. Careful inspection was given the area to find a possible route that could be located in a more advantageous position than the ones in the following paragraphs. However, due to the confines of steep side slopes and restrictions imposed by the railroad and stream, as well as multiple business locations, the two locations in this report are the only economically feasible placements that could be found.

Alternate L

Alternate L crosses Little Prickly Pear Creek at the west end of Wolf Creek and proceeds between the town of Wolf Creek and the mountains to the south.

The structure employed for this creek crossing would carry the Interstate over the creek, the railroad and the existing highway, U. S. 91. A ramp would precede this structure allowing traffic to enter this existing highway. The concrete bridge now in place would serve as access from this highway to the Stearns road and to Main Street. Due to a vertical clearance in excess of 25 feet, necessary over the railroad, the Interstate would be on a sizable fill. Some channel change in the stream would be required west of this structure. As shown in the Right-of-Way section of this report, a considerable amount of expensive business property must be purchased to facilitate access for this highway. At this point, Alternate L is generally on the present highway alignment. It follows this existing alignment to the end of the studied section.

Alternate L has the lowest initial construction cost and, due to the elimination of a considerable portion of present highway, it will have a lesser maintenance cost.

However, it should be pointed out that the existing highway is a tangible item constructed at a considerable expense to the taxpayers of the State. Although it is inadequate to meet the expanding traffic volume and increased traffic speeds, it is by no means exhausted of its capabilities as a conveyance medium. To consider this highway expendible is to waste any potential that this highway could contain. From surface investigations made at the proposed bridge locations on all alternate locations it has been determined that Alternate L will have a more advantageous bridge site, due to the possibility of rock existing at a feasible depth for bridge foundation for a part of the structure. The existing Missouri Bridge rests on rock. Limestone, sandstone, and volcanic rock will be intermittently encountered throughout the length of Alternate L. Inspection of this rock shows that blasting will be required in these rocky areas. This alternate has a river grade. The roadway would be a four-lane narrow median section to a point 2 miles north of the Missouri River crossing.

The northerly half of this alignment has gradients and curvature that will conform to the standards set up to allow 2 lane construction at present with a provision for 2 lanes to be added in the future. However, with this alignment little of the present road could be retained as frontage road. It is doubtful that the construction of a frontage road in the future would be justified, due to the confining nature of the rock cliffs and the Missouri River. It would be necessary to construct at-grade crossings in two locations on this alternate. Future access at these points would have to be purchased. High valued agricultural properties lying between this location and the Missouri River would be isolated due to the controlled access feature of the Interstate. There would be essentially no access to the Missouri River or to the mountains to the east for sportsmen. Three interchanges would be required, one at Wolf Creek, one at the easterly end of the Missouri River bridge, and one at the Craig road.

Alternate L is the longest of all studied routes and would have the highest annual cost expenditure. There is no reduction in existing primary mileage.

The bridge presently serving as access to the town of Craig is old and restricted in both clearance and load limit. The bridge was constructed in 1903. No Interstate funds can be allocated for the replacement of this structure. Although an inspection of the bridge shows that it is in surprisingly good condition for its age, it is reasonable to assume that its life will be spent much before the life of the Interstate. At this time a new bridge would have to be constructed to carry traffic from the Interchange on Alternate L to Craig. Though this cost is not now applicable, it must be kept in mind for the future while considering Alternate L. The maximum profile gradient for this location is 3.5%. The summation of horizontal deflection angles is 535 degrees. The length is 11.77 miles.

Alternate M -- The Recommended Location

The location recommended for this project follows the west side of Little Prickly Pear Creek through the town of Wolf Creek and will then continue northeasterly to an intersection with the Augusta road at a point one mile from town. It then continues across a broad flat to a saddle in a rocky point east of Rock Creek. From this point it proceeds generally parallel with the Missouri River and passes a few hundred feet west of the town of Craig from which it continues to a bridge across the Missouri River located about one-half mile south of Stickney Creek and then to a point in the present road just north of Stickney Creek.

The roadway will be a four-lane narrow median highway with 6-foot shoulders, four 12-foot traffic lanes, an 8-foot flush median, and a median barrier guard rail, which is required as a standard of the Montana Highway Department, from the Beginning of the Project to a point just beyond the intersection of the Augusta highway. At this location there will be a transition to a four-lane wide median highway employing 10-foot outside shoulders, four 12-foot traffic lanes and a 36-foot median. West of Rock Creek there will be a transition back to the aforementioned narrow median section. Another transition 2 miles south of Craig will be to the 4-lane wide median and yet another, one mile north of Craig will be to the narrow median section. This last transition will precede, by short distance, a transition to a 2-lane highway. This two-lane section will continue across the Missouri River bridge and to the End of the Project.

Four interchanges are proposed on this alternate, one in Wolf Creek, one at the Augusta Road intersection, one at Craig and one at the north end of the Missouri River bridge. These interchanges will be discussed in detail in the section entitled "Interchanges." The significance of having an interchange in Wolf Creek and another at the Augusta road intersection is great. A section of existing primary highway will be replaced by the advantageous Interstate highway allowing users of the Augusta road a better service to Wolf Creek. A better service to the users of the Augusta highway will also result through the elimination of the necessity of travel on the Main Street of Wolf Creek in order to reach Highway U. S. 91.

The portion of Alternate M that passes through Wolf Creek importunes a more detailed explanation. On the west end of town, a south bound on-ramp will carry traffic from the Main Street and the Stearns highway onto the Interstate. In the center of town the Interstate will cross over a road giving access from Main Street to the existing highway U. S. 91, which will then be a frontage road. The Interstate will be on a fill on each side of this structure. The height of fill will approach 20 feet. Two ramps, one on each side of this crossroad will connect to the north bound lane of the Interstate. At the east end of town there will be a south bound off-ramp that will bring traffic from the Interstate onto the Main Street. All of the area between the railroad and the Main Street will have to be purchased for the right-of-way. There will be no disturbance of the property north of Main Street. The channel of the creek will have to be changed to run parallel with and adjacent to the railroad. It will be necessary to relocate the present railroad depot to the south side of the railroad track.

There are two broad flat areas that will be crossed on this alignment. In these areas it will be economically feasible to construct a 4-lane wide median highway. Location M will have a great percentage of 4-lane highway. The safety provided by a 4-lane highway as opposed to a 2-lane highway is a feature that is difficult to evaluate accurately in dollars. This alternate has no at-grade intersections. It has been proven conclusively that at-grade crossings instigate accidents. No workable means has yet been devised to extrapolate the number of fatal accidents foreseen, and it is not possible to place a dollar value on a human life. However, a study made of accident experience in relation to highway types and design elements by A.A.S.H.O. shows that the accident rate per million vehicle miles on 2-lane highways having less than 5,000 ADT is 3.5, and on 4-lane divided highways is too small for a reliable computation. Line M will be one of the safest alignments.

Alternate M does not necessitate the use of the Craig bridge for access to Craig. This is beneficial since the life expectancy of this bridge cannot be determined accurately. It is conceivable that through a more direct access to the town of Craig, business opportunities will be presented that never before could exist. The present highway will be retained from Wolf Creek to Stickney Creek, thus affording the public easy access to the area for hunting, fishing and recreation as well as agricultural purposes. Alternate M is the shortest proposed alignment and has the lowest annual cost. Of all alternates studied, it has the highest benefit cost ratio.

The maximum profile gradient for this line is 5%. The summation of horizontal deflection angles is 443 degrees. The length is 10.83 miles. There will be 5,300 feet of channel change on this alignment.

Alternate N

Location N is identical to Alternate M through Wolf Creek and to a rocky point northeasterly of Rock Creek. From this point it would proceed across the Missouri River and continue on the same alignment as Alternate L to Stickney Creek. This location was investigated as a logical attempt to reduce alignment curvature. However, the length of the line produces a high road users cost in contrast to the majority of the other lines. Alternate N would necessitate the use of the Craig bridge for access to that area across the Missouri River. This, as has been discussed previously, is not a favorable condition. The maximum profile gradient for this line is 5%. The summation of horizontal deflection angles is 390 degrees. The length is 11.26 miles. There would be 5,300 feet of channel change on this alignment.

Alternate O

Alternate O was investigated as being the location that would traverse Wolf Creek on the north side of Little Prickly Pear Creek and yet essentially be the same location as Alternate L. After proceeding through Wolf Creek, Alternate O follows through a wooded grazing area from which it crosses over the Great Northern Railroad onto a hay field. The Missouri River crossing on this alignment would be located a few hundred feet north of the crossing proposed for Alternate L. Location O becomes the same as Location L one half mile northeast of this river crossing and is identical to the End of the Project. A transition from a 4-lane highway to a 2-lane section would be necessary two miles northeast of the Missouri River Bridge. The highway north of this point would be 2-lane.

The flexibility and practicability of having an interchange within the town of Wolf Creek is extremely important. All lines except Location L would afford this advantage. The remainder of Alternate O, being identical with Alternate L, would have the service and handicaps attributed to that location. However, between Wolf Creek and the Missouri River, an area of poor soil condition exists. Two exploratory soil borings were made in this area. The tests performed on the samples from these boring holes indicated that the area is overlain with approximately a 2-foot depth of organic soil not suitable for subbase material. This material would necessarily have to be removed and replaced with a more suitable subbase material before the Interstate could be constructed on it. The additional cost for this material replacement is added into the earthwork column of the Cost Summary and Comparison of Alternate Locations. If a highway is to be constructed on this alignment, a comprehensive soil analysis must be recommended. The construction criterion will then be based on the conclusions drawn from this analysis. Within this area there is recommended an interchange for the Augusta road connection. All increased costs applicable to the Interstate through-way, due to the poor soil condition, will be pertinent to the construction of this interchange.

Within this area, there must be 9,700 feet of channel change. The maximum profile grade on this alternate is 3.09%. The summation of horizontal deflection angles is 441 degrees. The length is 11.55 miles.

Alternate P

The alignment of Location P is identical to that of Alternates M and N to the rocky point northeasterly of Rock Creek. From this point the line proceeds more closely with the railroad and continues through the town of Craig. One and one-half miles north of Craig this alignment again becomes identical with Alternate M and continues on this alignment to the End of the Project. The transitions on this alignment would be placed generally the same as those proposed on Alternate M.

Alternate P would have two segments of 4-lane wide median highway. Because Location M and Location P are identical, excepting the portion of line P that traverses Craig, it is evidenced from the highest cost of Alternate P that this location in Craig is less desirable.

The maximum profile grade on this alternate is 5%. The summation of horizontal deflection angles is 182 degrees. The length is 11.00 miles. There will be 5,300 feet of channel change on this alignment.

Alternate Q

As has been mentioned earlier in this report, Location Q was the tentative alignment submitted by the Montana Highway Department to the Bureau of Public Roads as a location for cost estimates. This alignment traverses Wolf Creek on the north side and follows parallel with the railroad approximately 3 miles. From this point it would break its adjacency with the railroad and ascend to a rocky point northeast of Rock Creek. At this point the line is identical with Location P and follows this alignment to the End of Project. The first two miles of Alternate Q are identical with Alternate O and would therefore impute Alternate Q with the soil condition and channel change of Alternate O.

Alternate Q would be a 4-lane narrow median section to a point 2.5 miles south of the town of Craig where it would transition to a 4-lane wide median highway. One and one-half miles north of Craig there would be another transition to a 4-lane narrow median section and would be closely followed by another transition to a 2-lane section. The last two transitions mentioned here are identical with Location M and this alignment follows Line M to the End of Project. Location Q would be the most costly construction project of all Alternate locations. Location Q affords no benefits surpassing any other alternate. The maximum profile gradient on this alternate is 5%. The summation of horizontal deflection angles is 565 degrees, the greatest of all alternates. The length is 11.18 miles. There would be 11,800 feet of channel change on this alignment.

Alternate R

The location of Alternate R is identical to that of Alternate Q to the aforementioned rocky point northeast of Rock Creek. From this point Location R is identical to Alternate M to the end of the studied section. Location R would involve the same soil problem that would be encountered on Alternates O and Q. These alternates will not afford the users of the Augusta Road as convenient a connection to the interstate as will the Alternates M, N and P.

The maximum profile grade on this alternate is 5%. The summation of horizontal deflection angles is 526 degrees. The length is 11.01 miles. There would be 11,800 feet of channel change on this alignment.

Interchanges

In the following paragraphs, location and some design factors will be discussed on all proposed interchanges. Each interchange has constituents of grade and alignment pertinent to good engineering. No condescendence was necessary for economic feasibility or favorable access.

Wolf Creek Interchanges

Traffic studies made in the Wolf Creek vicinity indicate a necessity for an interchange to serve the residents and patrons of this community.

The interchange on Alternate L would be located one half mile east of Wolf Creek, immediately south of the present Great Falls highway. It would be a diamond type. Two frontage roads would be required to provide access to the east, one north and one south of the Interstate. The crossroad would be under the Interstate and would bridge the railroad and creek to the north, joining the present Wolf Creek-Augusta road. An at-grade crossing at the railroad on this crossroad is not considered desirable due to an ADT of 190. Ramp roads do not exceed a gradient of 4.38%. This interchange would have excellent drainage and soils in this area are quite stable, providing adequate bearing for the structure. A pair of ramps would have to be constructed west of Wolf Creek to prevent a "doubling back" of Helena-Wolf Creek traffic. The off-ramp north-bound would have an at-grade railroad crossing with an automatic flashing signal. With a small volume of trains (presently an average of four per day) using the railroad and relatively low future traffic count, the at-grade crossing is all that is warranted and is acceptably safe. A new small bridge designed to minimum standards would be required for the creek crossing. The interchange for all alternate locations other than Alternate L will be within the town of Wolf Creek. A very thorough investigation has been conducted in locating this interchange. It will be of the diamond pattern. The crossroad will be under the Interstate and will extend from State Highway 287, presently Main Street, across the creek and railroad to the existing Great Falls highway. This crossroad will be located 300 feet south of the present bridge in the center of town, and will provide the only access from one side of town to the other. The south-bound on-ramp of this diamond interchange will be constructed sufficiently west of town to allow access to the Interstate from the Wolf Creek-Stearns road. Adequate clearance is not available at any location nearer to the center of town for the construction of this ramp. The south-bound off-ramp of this interchange will join directly with the east end of Main Street which is presently State Highway 287. All south-bound traffic leaving the Interstate at this location will travel on this street. The north-bound on and off-ramps will be in the center of town between the Interstate and the proposed channel change. The channel change will be parallel with the railroad and will run the full length of the town. To provide the necessary clearance for this channel change, the siding on the north-side of the main railroad track will be removed and the depot relocated. Right-of-way will be purchased between Main Street and the railroad. However, there will be no disturbance to any property north of Main Street.

The Interstate will be constructed on a fill to provide clearance of 14 feet for the crossroad. Sidewalks will be constructed for complete pedestrian traffic under the Interstate. Justification for this interchange will be found under the section on Economic Analysis.

Augusta Road Interchanges

Due to inadequate space in the town of Wolf Creek, the interchange proposed for Alternate L was located east of the town. This interchange is explained in the preceding section, Wolf Creek Interchanges. This interchange would have a crossroad connecting directly to the Augusta road, thereby serving Augusta road travel as well as Wolf Creek travel. All other alternates have an interchange proposed within Wolf Creek. In addition to this Wolf Creek interchange on these alternates an interchange is proposed slightly over one mile northeast of town to serve the Augusta road.

The interchange recommended for Alternates M, N and P will be located at the crest of the hill on the present primary highway to Augusta, F.A.P. 238 (State Highway 287). This primary serves as a connection to F.A.P. 50 (State Highway 20) which lies 23 miles north of Wolf Creek and continues northwesterly, passing through the town of Augusta, 43 miles from Wolf Creek.

An interchange here is desirable and justifiable, based on the following points:

(1) It provides the shortest direct connection between the Interstate and this state primary highway.

(2) Since the Interstate has four lanes at this location, any connection must have controlled access which an interchange provides.

(3) The 1958 ADT on this primary is 289, which would prohibit an at-grade connection even if the Interstate were only two lanes at this point.

(4) If an interchange were not provided, a grade separation would still be necessary.

Due to an A.D.T. of 450 for the Augusta road, a trumpet type interchange for a "No Stop" condition is recommended. A plan view of this layout is shown on Figure No. 6. Frontage roads will not be necessary in this interchange area. The crossroad will be on the existing Augusta highway alignment and will be under the Interstate. Foundation materials for the structure in this area are dry and stable.

The interchange planned at the junction of the Augusta road with Alternates O, Q and R will be located between the railroad and the hill to the north. The plan layout would be similar to the one just described for Alternates M, N and P. It would also have a "No Stop" condition. The crossroad would be over the Interstate. This would produce a favorable gradient on the primary road carrying north-bound traffic. This primary will be a new section of roadway that will connect the interchange with the existing highway at the crest of the hill.

Frontage roads are not required in this area. Therefore, ramp speeds could be designed higher than those on a diamond type interchange where "Stop" conditions exist. Sufficient acceleration and deceleration lanes length can be provided with angles of convergence for ramps of less than 5 degrees. A piling foundation is anticipated for the structure in this interchange. Justification for this interchange will be identical to the Augusta highway interchange for Alternates M, N and P, due to the similar design and service.

Craig Interchanges

An interchange will be necessary to serve the Craig area. The interchange planned for Alternates L, O and N would be a diamond type on the east side of the Missouri River. The crossroad would be under the Interstate and would connect to the east end of the existing

Craig bridge. This interchange would be located on the flat hay fields in this area and would involve high right-of-way costs.

Alternates P and Q would necessitate a diamond interchange in the town of Craig. The crossroad would be under the Interstate. A frontage road would be necessary with this interchange to provide access to the farms to the south that would lie between the Interstate and the Missouri River. This location creates a problem with the Craig school and the Craig firehouse. These buildings are of a nature that will not allow moving and must be purchased or reconstructed elsewhere. Access service to Craig with this interchange is very good.

The recommended interchange for the Craig area would be on Alternates M and R. This diamond type will have the crossroad under the Interstate and be located a few hundred feet northwest of the town. No frontage roads will be necessary in this location. Craig will be served very favorably. Ramp road gradients do not exceed 5% and acceleration and deceleration lanes can be provided with angles of convergence and divergence for ramps of less than 5 degrees.

Present ADT from the existing highway to the Craig area is 60 vehicles and to the county road to the east along Wagner Creek is 30 vehicles. This is sufficient to justify an interchange in this vicinity for all alternates.

Missouri River Interchanges

The east end of the Missouri River bridge on each alternate location is within an area that will justify an interchange. The justification of this interchange incorporates the use of the river bridge as the interchange structure. The crossroad would be under the bridge adjacent to the river. Each of these interchanges is a half diamond type. The design of these interchanges is such that future expansion to a partial clover leaf with full service can be done with reconstruction of the ramps only. Justification for this interchange will be found under the section on "Economic Analysis."

Hydraulics and Drainage

This section of the report pertains to the hydraulic design involved in determining the peak design stream flows in Little Prickly Pear Creek, the Missouri River, and their tributaries. These flows will be used in the final design of bridges, pipe culverts, and channel changes.

Previous Data Analyzed

In the "Report on Location and Design, Interstate Route 15, Sieben to Wolf Creek," submitted to the Montana State Highway Commission, March 17, 1961, the Little Prickly Pear Drainage Basin was analyzed to determine peak flows. The data studied showed major floods in 1908 and 1953 on Little Prickly Pear Creek. However, the flow during these floods was not physically measured, and it was necessary to compute the 1953 flood flow from slope-area determinations as indicated by channel conditions in the fall of 1960. From this data, a Peak Discharge Curve for the Little Prickly Pear Drainage Basin was computed, using Meyer's Equation. The design flood flow for Little Prickly Pear Creek near the town of Wolf Creek was determined to be 4400 cubic feet per second.

After submission of the March 17 Report, the estimated flood flows in the Little Prickly Pear Drainage Basin were studied by the Montana State Highway Department Hydraulics Engineer and U. S. Bureau of Public Roads Engineers. Their conclusions were that design flows approximately 15% less than those recommended in this March 17 Report would be adequate for the final design of structures and channel changes in the Wolf Creek area. The flows recommended in the Report for drainage areas of 1 to 10 square miles were satisfactory for final design. Final design flows for intermediate areas are to be proportionately reduced between the 10 square mile drainage area and the drainage area at Wolf Creek.

The runoff from smaller drainage areas has been computed using the Meyers Equation Peak Discharge Curve for Little Prickly Pear Creek or the Talbot Formula using a rainfall intensity of 1.5 inches per hour. Runoff in the area under consideration is more rapid and slightly higher than that which occurs in the Little Prickly Pear Drainage Basin. However, the Discharge Curve used in the previous report is accurate enough for the purposes of determining the preliminary design criteria in this report.

In final design, runoff for areas up to 5 square miles will be based on "A Simplified Method For the Hydraulic Design of Culverts," a Bureau of Public Roads Publication prepared in 1956. For drainage areas from 5 to 10 square miles the above mentioned Little Prickly Pear Discharge Curve will be used. For drainage areas over 10 square miles this discharge curve will be modified as mentioned above.

Missouri River Floods

Peak flows in the Missouri River have occurred in 1908, 1948 and 1953, with the 1908 high water being the apical height. Since 1908, dams at Canyon Ferry, Hauser and Holter have reduced the peak flows below that of 1908 and it is very unlikely that flows approaching the 1908 peak will be reached in the future.

Calculations have been made to determine the effect of the anticipated future flood flows relative to the high water elevation. The conclusions reached show that high water marks recorded in the past will be adequate for determining Interstate profile and bridge heights over the River. The reduction of past flood flow elevations as a result of greater regulation of the Missouri River with recent dam construction would be too small to warrant consideration.

Culvert Summary

A considerable number of small drainage pipes will be necessary for all considered alternates. These will drain small areas adjacent to the Interstate highway. The following summary contains drainage pipes over 60 inches in diameter:

Line	Station	Diameter	Stream
L	599+00	72"	
	671+60	84"	
L, O	817+00	102"	
L, N, O	870+00	78"	
	926+00	60"	
	948+00	66"	

Line	Section	Diameter	Stream
L, N, O	1010+80	3-108"	Wagner Creek
M, N, O, P, Q, R	543+00	16'6"x11'0"	
M, N, P	746+00	180"	Rock Creek
P	804+00	2-60"	
P, Q	872+00	66"	
	936+00	168"	Dog Creek
	1016 00	96"	
M, R	804+00	2-60"	
	922+00	168"	Dog Creek
	947+00	66"	
	1001+00	96"	
Q, R	720+00	96"	
	759+00	180"	Rock Creek
Q	816+00	84"	

Major Structures

General

This discussion of major structures covers the interchanges, bridges and overpasses required for the Wolf Creek to Stickney Creek section of Interstate Highway 15. Preliminary layouts and cost estimates based on the use of deck type structures were prepared for all major structures considered on the various alternate locations. The cost areas for these structures were determined using the overall width of structure plus one foot, and length of the structure between centerline of bearings on abutments, in accordance with the MSHC Bridge Department practice. These cost estimates were utilized in the overall construction costs of the seven highway locations studied. A cost summary of all structures appears in Figure 202. Locations of all structures considered are shown on the Location Plan of Alternates Studied on Pages 4 and 5, and are also indicated on the Plan-Profile drawings.

All structures will be designed in accordance with the latest edition of the A.A.S.H.O. Standard Specifications and current Montana Highway Department Standards. All structures, except one in Wolf Creek, will be provided with 1'-6" wide safety curbs and the latest standard bridge rail used by the State. Structure PW-40 in Wolf Creek will be provided with 4'-0" sidewalks for pedestrian travel.

Shoulders equal in width to those on the roadway adjacent to the structures will be used on structures shorter than 250 feet in length. On longer structures the shoulder width is reduced in accordance with Interstate bridge standards to 2 feet.

Following selection of Alternate M as the most feasible location for the Interstate Highway in the Wolf Creek to Stickney Creek area, an exhibit layout (Figure 26 through 32) for each of the proposed structures on this location was prepared. Eight major structures are required for the recommended location. Three of these will be interchange structures only; one will be a bridge across the Missouri River for the Interstate Highway, and will incorporate an interchange; one will be a railroad overpass for the Interstate Highway; one will be a bridge for the Interstate Highway across Stickney Creek; one will be a bridge for an access road across Little Prickly Pear Creek; and one will be a bridge over the Interstate for a county road.

Abutments may be either the spill-through type or stub abutments, depending on soil conditions and scheduling of the construction. Both types of abutments have been shown on various exhibits. Due to the varying nature of the geology in the area and the deep overlying sediments in the Missouri River, it is expected that pile foundations will be required under some structures. The structure exhibits do not show pile foundations, but the "Summary of Preliminary Cost Estimates of Structures" shows the structures for which pile foundations have been computed.

Preliminary Cost Estimates

Preliminary cost estimates for this study are based on square foot unit costs developed after reviewing structure contract awards by the MSHC for the years 1959, 1960 and 1961. Unit costs of $10.50 per square foot of pre-stressed concrete girder construction and $11.50 per square foot for rolled steel girder construction were used. The costs of the bridge across the Missouri River were computed by preparing a preliminary design and cost estimate for a typical structure, incorporating welded built-up girders. From these preliminary cost estimates, a unit cost of $15.00 per square foot was determined as a reasonable cost for the bridges under consideration.

On curved structures, the unit costs were increased five per cent due to inherent increased construction difficulties. Costs of retaining walls, including metal bin wall used to retain approach fills, have generally been added into the total structure estimates. An allowance of eight to twelve percent of the total construction cost has been added to bridges in locations where pile foundations are anticipated.

An allowance of ten per cent has been added to cover contingencies. Channel change costs are included in the grading work estimates.

Design Loadings

The six structures carrying the Interstate Highway will be designed for a H 20-S 16 structure loading or for the alternate military wheel loading where the alternate load is more severe. The bridge structures for the access road at Wolf Creek and the county road structure near Rock Creek will be designed for an H 15-S 12 structure loading.

Foundation Investigations and Site Surveys

When work on construction plans is commenced, a detailed site survey will be made at each structure location and foundation borings will be made. Final construction layouts will reflect the requirements of this more detailed site information.

Structure PW 30

WOLF CREEK INTERCHANGE

The Wolf Creek Interchange will carry the undivided four-lane, narrow median, Interstate Highway over a local road that connects the present U. S. 91 and Montana 287 highways. The structure is on a 1° 15' curve. The proposed layout is shown in Figures 3 and 26.

The road under the interchange will have a 36-foot width, plus four foot sidewalks on each side. The road will pass through the center span and the sidewalks through the end spans. The cost of the bin wall, utilized to retain the fill under the structure and the embankments parallel to the highway, has been included in the grading cost estimates. A maximum vertical clearance of 14'-0", plus an allowance of 4 inches for future surfacing is provided.

The structure consists of 3 spans of cast-in-place flat slab concrete deck. Use of this type of deck, allows for a lower interstate profile, and consequently less roadway fill and bin type retaining wall. This type of structure is slightly more expensive than pre-stressed concrete beam and slab, yet the saving in grading quantities will offset the increased structure cost. It has been indicated by the residents of Wolf Creek that the lowest possible fill is the most desirable for them from the standpoint of appearance. Pile foundations are anticipated at this location.

Structure PW 40

BRIDGE ACROSS LITTLE PRICKLY PEAR CREEK FOR ACCESS ROAD AT WOLF CREEK

The Wolf Creek Interchange, providing access through a local road to the present U. S. Highway 91 and Montana Highway 287, will require construction of a bridge across Little Prickly Pear Creek in the immediate vicinity of the interchange. Figures 3 and 26 illustrate the layout. The bridge will consist of a single 80-foot span incorporating closed end abutments. Restrictions due to the location of the interchange, eliminate the use of open-end abutments and require a wider structure to accommodate the large truck turning radii.

The structure will be 36 feet wide between curbs and a 4-foot sidewalk will be provided on each side of the structure. Steel wide-flange girders will be utilized to support the concrete deck. A pile foundation is anticipated in this area.

Structure PW 60

AUGUSTA HIGHWAY INTERCHANGE

The Augusta Highway Interchange will carry the 4-lane undivided, narrow median Interstate Highway, plus an acceleration lane over the Augusta Highway. The proposed layout is shown in Figures 6 and 27.

The structure will provide a minimum vertical clearance of 14'-0", plus an allowance of 4 inches for future pavement and a minimum horizontal clearance of 44'-0". The lengths of available standard precast beams will effect a horizontal clearance of 46 feet. The interchange will be constructed of MSHC standard precast, pre-stressed concrete girders, supporting a concrete deck. Prestressed concrete girder spans of 55 feet and 40 feet will be employed. The structure width, including acceleration lane which will be carried at a 9-foot width across the structure, is 77'-0".

The Augusta Highway will pass through the center span. Open-end spans will permit termination of the Interstate Highway road embankments in an attractive and economical manner. It is anticipated that spread footing foundations will be used.

Structure PW 105

BRIDGE OVER INTERSTATE ON COUNTY ROAD

In order to provide access from one side of the Interstate to the other between Augusta Interchange and Craig, the continuity of the county road will be maintained. It will cross over the Interstate at Station 731+00. Figures 9 and 32 illustrate this layout.

The structure will provide a minimum vertical clearance of 17 feet, plus an allowance of 4 inches for future pavement and a minimum horizontal clearance of 74 feet.

The structure will be 28 feet wide between curbs. Continuous steel wide-flange girders will be used to support the concrete deck. There will be three spans, 54 feet, 80 feet and 54 feet in length. A spread footing type structure foundation is planned for this structure.

Structure PW 135

CRAIG INTERCHANGE

The Craig Interchange will carry the divided 4-lane Interstate Highway over a local road that connects Craig on the east to the farming land on the west of the Interstate Highway. This structure is on a section of tangent highway. The proposed layout is shown in Figures 16 and 28. The road under the interchange will have a 24-foot width. The interchange will provide a minimum vertical clearance of 14'-0", plus an allowance of 4 inches for future added pavement on the road below. The minimum horizontal clearance is 32'-0".

The Interchange will include two similar structures constructed with precast, prestressed concrete girders supporting a concrete deck. Each structure will consist of three spans utilizing MSHC Standard 35-foot and 40-foot prestressed girders. The local road will pass through the center span. The open-end spans will permit termination of the Interstate Highway road embankment in an attractive and economical manner. Since the structures are relatively short, the full 38-foot shoulder-to-shoulder roadway widths will be carried across the structures. Spread footings are planned for the substructure.

Structure PW 145

OVERPASS OVER THE GREAT NORTHERN RAILROAD

The recommended line requires a structure over the Great Northern Railroad in the vicinity of the Missouri River Bridge. The Interstate Highway in this area is narrowed to a two-lane highway, as indicated on the exhibit layout, Figures 19 and 29.

The structure will require seven spans and be approximately 166 feet in length, due to a high skew angle crossing of 64 degrees. Rolled steel girder spans are planned at the railroad and MSHC standard prestressed concrete girders at other locations. A steel girder straddle bent will be placed across the railroad. Other bents for the structure will be concrete "T" bents.

A minimum vertical distance of 23'-0" plus an allowance of 6 inches for future ballast will be provided over the railroad. Off track equipment along the railroad track may be operated through the structure. It is proposed to provide minimum horizontal railroad clearance of 10'-0" to the straddle bent on each side of the railroad centerline at this location. The horizontal clearance to the toe of the roadway fill is 14 feet. Approval of the Great Northern Railway Company will be required for the railroad clearances and final layout. Adequate access will remain to the field east of the structure.

Due to a structure length in excess of 250 feet, the 2-foot minimum clearance width will be used from the roadway to the curb rather than the 10-foot roadway shoulder width. Approach fills on the railroad side of the Interstate have been steepened to 1.75:1. Piles are considered a requirement at this location.

Structure PW 155

BRIDGE OVER THE MISSOURI RIVER AND RAMP

The selected Interstate Highway location requires crossing the Missouri River at a location between Craig and Stickney Creek. As indicated in the exhibits, Figures 20 and 30, the highway in this area is a two-lane highway. In addition to crossing the river, the bridge crosses an access road at the north end of the structure. The function of this road is explained under the section on Interchanges.. The added length to provide the horizontal clearance for the road under the north end is 55 feet and the added bridge cost is $22,000.

The structure will be composed of 8 spans and be approximately 827 feet in length. Three steel wide-flange approach spans will be used in conjunction with a 562-foot, 5-span, continuous structure across the river. "T" bents will be used in the river and open-end bents and standard two-column bents used at the other locations.

As stated previously, the structure cost is based on the use of welded steel built-up girders. Welded girders have been used in numerous states with good results. With proper radiographic inspection of webs, a fully satisfactory structure should result. It is anticipated that field splices will be bolted. This structure will exceed 250 feet, therefore, a 2-foot minimum clearance width will be used from the roadway to the curb as opposed to the 10-foot roadway shoulder width. A pile foundation may be required in this area.

Structure PE 135

BRIDGE ACROSS STICKNEY CREEK

Near the end of the project, the two-lane Interstate Highway crosses over Stickney Creek. The required structure, as shown on Figures 21 and 31, will be a precast, prestressed concrete girder and slab bridge of 3 spans. Standard MSHC prestressed girders of 35-foot and 60-foot spans will be used. Full shoulder to shoulder width of 31'-0" will be carried across the structure.

The present channel, as constructed by the MSHC after a bridge washout on June 5, 1953 has a sixty-foot bottom. The new structure provides for this same channel width, and also for approximately six feet of free board over extreme high water. The previous bridge failure in the area was caused by a large cottonwood obstructing the channel at the structure, thereby causing the water to scour out the structure foundation. Large cottonwoods are still present upstream.

Economic Analysis

An economic analysis in the form of a road user benefit study is made to compare on a cost basis alternate locations or routes with similar terrain and design conditions. For a valid comparison, the type of highway facility and the traffic served should generally be the same. The results of this analysis is a cost comparison which proportions due consideration to the items that can be evaluated in terms of true cost in dollars.

More than the initial construction costs must be considered. This has long been recognized as revealed in the statement from "A Manual of the Principles and Practices of Road-Making" by W. M. Gillespie published in 1846. To quote: "A minimum of expense is, of course, highly desirable, but the road which is truly cheapest is not the one which has cost the least money, but the one which makes the most profitable returns in proportion to the amount which has been expended upon it." Items to be considered are construction, maintenance, and vehicle operating costs.

The residents of the immediate vicinity of a proposed highway improvement should be interested and concerned with its location. Also the non-resident road user is concerned with the cost of construction and maintenance since it is highway-user taxes and fees which provide the major source of funds for highway facilities. The road user is also interested from the standpoint of vehicle operating costs.

This report evaluates road user costs for automobiles for different conditions of operation on highways of various types. These consider the following variables as tabulated in the 1960 A.A.S.H.O. informational report.

1. Type of Vehicle
    a. passenger car
    b. truck or bus
2. Type of area
    a. rural
    b. urban
3. Type of Highway
    a. 2-lane
    b. divided
4. Type of Operation
    a. free
    b. normal
    c. restricted
5. Running Speed
    a. range of likely values
6. Gradient Class
    a. 0 to 3 percent
    b. 3 to 5 percent
    c. 5 to 7 percent
    d. 7 to 9 percent
7. Type of Surface
    a. paved
    b. loose surface
    c. unsurfaced
8. Alignment
    a. tangent or flat curves
    b. curved

Road Users Benefit Analysis

The most economical location of the seven alternates investigated for this project was determined by a road user benefit analysis. The analysis was made according to the 1960 A.A.S.H.O. informational report on "Road User Benefit Analysis for Highway Improvements, Part 1, Passenger Cars in Rural Areas." Both the 1958 ADT and the projected 1975 ADT were determined from information received from the Montana Highway Department. See drawings of Traffic Volumes and Turning Movement on pages 25, 26, and 27. The average annual daily traffic was considered for 1972 which covers a 20-year period, from 1962 to 1982, and is consistent with the above informational report. The year 1962 was used to be consistent with the previous report on the location and design from Sieben to Wolf Creek. The average annual daily traffic, 1972 ADT, was determined as a straight line proportion between the 1958 ADT and the 1975 ADT.

Truck traffic is 15% of the annual average daily traffic, and the unit vehicle operating and time costs for commercial vehicles were considered at 3.5 times that for passenger cars. All unit costs of vehicle expenses were used as published in the above informational report except the unit cost of gasoline, which was increased from 32 cents to 40 cents per gallon to reflect the current prices in Montana.

The average grade and curvature was considered for all sections of each line in determining the unit cost. Operation was considered "free" on 4-lane sections and "normal" on 2-lane sections of the Interstate locations. The existing highway, or basic condition, is a "restricted" operation.

A running speed of 56 MPH was used for 4-lane sections of the proposed Interstate and 52 MPH on 2-lane sections. Speed checks performed with unmarked state cars revealed an average running speed above 55 MPH for all traffic on the present highway in this area. The present highway U. S. 91 was used as the basic condition with a running speed of 40 MPH in the Wolf Creek area and 44 MPH on the remainder of the highway. If the existing highway was maintained until 1975 the increase in traffic would cause a restricted condition and a decrease in running speed. Total construction maintenance and road user costs are shown in Tables 1, 2 and 4 for the alternate locations. An interest rate of 4% was used which compares with recent long term municipal bond investments in this area. The estimated service life of the various highway construction items are as follows:

Right of Way	50 Years
Grading and Drainage	40 Years
Major Structures	50 Years
Surfacing	20 Years

Benefit-Cost Ratio

A proportion termed the benefit-cost ratio can be computed. It is the relationship of benefits to costs and indicates the return in the form of road user benefits on the investment for the improvements. A ratio of one indicates that the annual difference or saving in road user cost is just equal to the annual cost of the improvement, maintenance and operation of the highway.

Another method of comparison may be developed without the basic condition. Table 4 shows the annual savings in favor of the recommended line, Alternate M, over all other alternates considering all costs prorated to an annual basis.

Benefit-cost ratios for the Alternate locations are shown in Table 3. Location M has the best benefit-cost ratio. This is 1.122. Alternate M is the shortest route studied and this savings to the road user is reflected in the higher benefit-cost ratio. The construction costs used to determine these benefit ratios do not include engineering and contingencies. Traffic movements on all frontage roads which would affect the road user were considered for all lines. Interchanges with questionable justification will be investigated from the standpoint of a benefit cost ratio in the following paragraphs.

Wolf Creek Interchange

The interchange located at the intersection of the proposed interstate and the primary Highway to Augusta is justified as shown in the section on interchanges. Since the proposed interchange on the north side of Wolf Creek is in the vicinity of this interchange, it will be justified by a benefit-cost ratio determination.

A full interchange can be constructed within the town of Wolf Creek by the removal of a short siding of the Great Northern Railway and relocation of the existing depot. This is proposed for Alternates M, N, O, P, Q and R. Without this interchange, traffic entering from the south or leaving toward the south must travel east from Wolf Creek to an interchange to gain access to the Interstate. The additional mileage in this out-of-the-way travel would be 2.4. This extra travel would be made one-half on a frontage road and one-half on the Interstate. The unit cost per car mile is $0.1070. The minimum

ADT of any alternate is 320 vehicles, of which a portion will be generated traffic. A conservative estimate of 200 ADT will be used for the traffic from this direction. The annual cost to the road user would be $93.73 per vehicle or $18,716 for all traffic. The traffic entering from the north or leaving toward the north would have to travel 1.5 miles on a frontage road, 0.3 miles of this travel being additional distance and 1.2 miles being on roadway with a higher road users cost than on the Interstate. With an estimated ADT of at least 280 vehicles, the annual cost to the road user would be $10.24 per vehicle or $2,867 for all traffic. The total extra cost to the road user without this interchange facility would be $21,613.

Since the cost of this interchange could vary somewhat, depending on which proposed alignment it is used with, for purposes of justification the highest estimated interchange cost is used. Lower grades on Alternates O, Q and R cause the highest interchange cost. This cost would be $341,321, or $17,942 annually. Also, without this interchange at Wolf Creek, a frontage road must be constructed to facilitate travel from the Augusta highway interchange to Wolf Creek. This connection would require a bridge over Little Prickly Pear Creek and would result in a new at-grade railroad crossing. The least cost of any alternate for this connection would be $127,980, which produces an annual cost of $6,541.

The annual savings to the road user is greater than the annual interchange cost and the benefit-cost ratio is 1.20

$$\frac{21,613}{17,942} = 1.20$$

When considering the added cost of the interchange as compared to the cost of a minimum connection, the benefit-cost ratio is 1.90

$$\frac{21,613}{17,942 - 6,541} = \frac{21,613}{11,401} = 1.90$$

The cost of this interchange does not include the cost of the structure or the crossover road. The proposed alignment for this interchange divides the town of Wolf Creek and in order to provide access from one side to the other, the structure and crossroad must be built. The most costly part of this interchange will be the southbound off-ramp. This ramp is in a rock cut and in final design stages, with adequate provisions for signing, this ramp could possibly be shortened and made less costly.

Missouri River Interchanges

A half diamond interchange has been planned at the northern end of all Missouri River crossings to serve the Holter dam and Lake area from the Great Falls direction. This area has a great potential as a recreation area as well as current ranching activity. Without this interchange, O and L line traffic from or to the Great Falls direction would have to travel an additional four miles to reach this area. The estimated 1975 average daily traffic to this area is 60 vehicles. However, using a conservative ADT of 40 vehicles for justification purposes, and assuming 7 per cent commercial vehicles, the equivalent ADT is 47 vehicles. Using an average unit cost of $0.1126 per mile, since one-half the distance is Interstate and one-half is frontage road, the annual road user cost is $7,727. The most costly Missouri River interchange of all lines is $140,713 which is an annual cost of $7,578. The annual cost of the interchange is less than the annual cost to the road user without the interchange. The benefit cost ratio is 1.02. On Alternate N the extra distance would be greater and would show a larger benefit to the road user by construction of this interchange.

The same type interchange on lines M, P, Q and R also has an estimated 1975 ADT of 60 vehicles. Without this interchange, the traveling public must use the existing bridge at Craig to gain access to the southeastern side of the Missouri River. This would perpetuate the use of a bridge that was constructed in 1903. If failure should occur, the only access to this area would be from Wolf Creek.

A further consideration in favor of this interchange is that a grade separation here, for access to the river side of the Stickney Creek area, is less expensive than a grade separation farther northeast. The cost of an additional 55 foot span on this Missouri River structure is approximately $22,000. Consideration should be given to the continuity of a frontage road in this area using the existing highway to the south. An interchange to serve the area north of the End of Project will probably have to be considered. An extensive investigation of costs should be considered to ascertain whether it would be more economical to extend the half diamond to a partial cloverleaf for full service in all directions and provide a frontage road to serve the area to the north, or construct an interchange north of Stickney Creek and use the Missouri River bridge as a grade separation by elimination of the ramps. Either alternate would eliminate an at-grade crossing in this area, which is a hazard, and maintain this two-lane highway as controlled access. Using the Stickney Creek bridge for a grade separation would be impractical because at high water the frontage road would be inundated.

The solution to this problem will be dependent upon the alignment and traffic service study north of Stickney Creek. The cost of the half diamond was used on lines M, P, Q and R because it gives adequate service to the immediate area and a just comparison for all lines. It also gives adequate access to all property of the land owner in this area.

LEGEND

197[illegible] ADT
[illegible]

000
000

TURNING MOVEMENTS 1975 ADT — 00 →

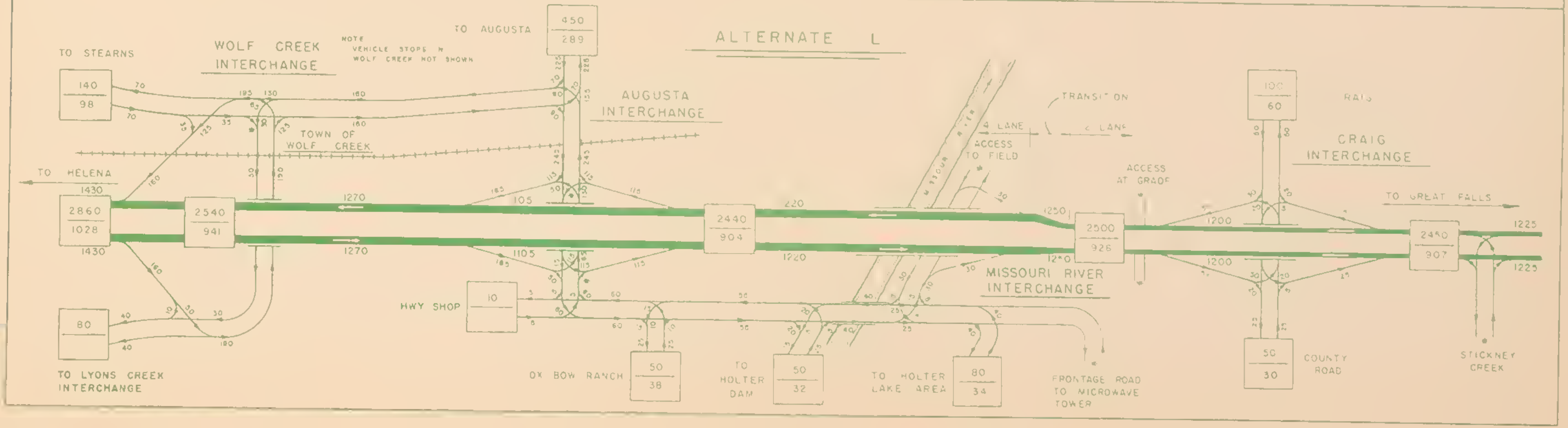
* 5 OR LESS VEHICLES

NOTES

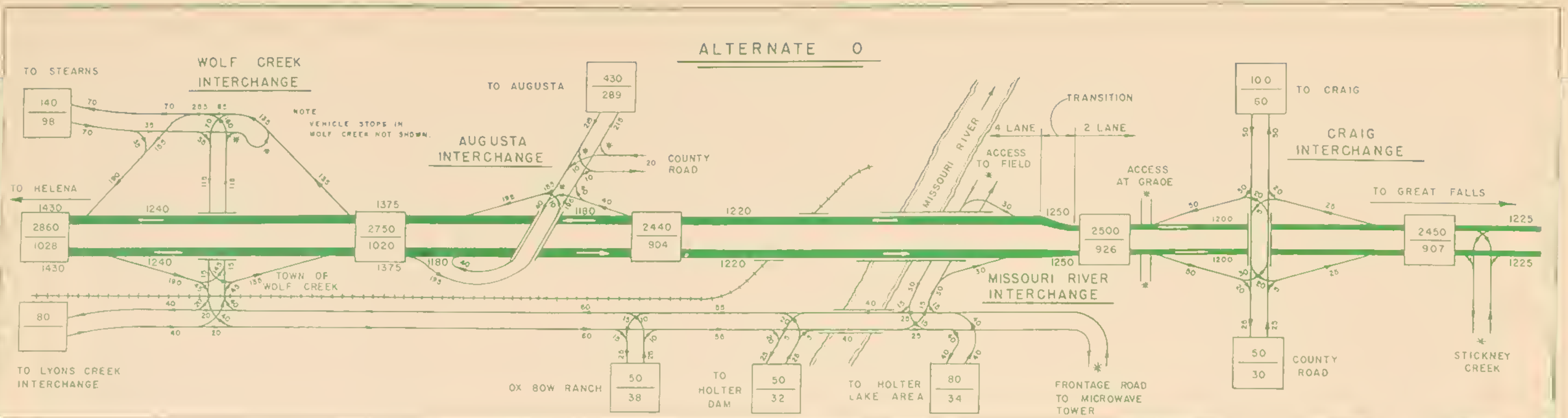
1 FIGURES FOR AVERAGE DAILY TRAFFIC (ADT) WERE OBTAINED FROM MONTANA HIGHWAY DEPARTMENT

TRAFFIC VOLUMES & TURNING MOVEMENTS

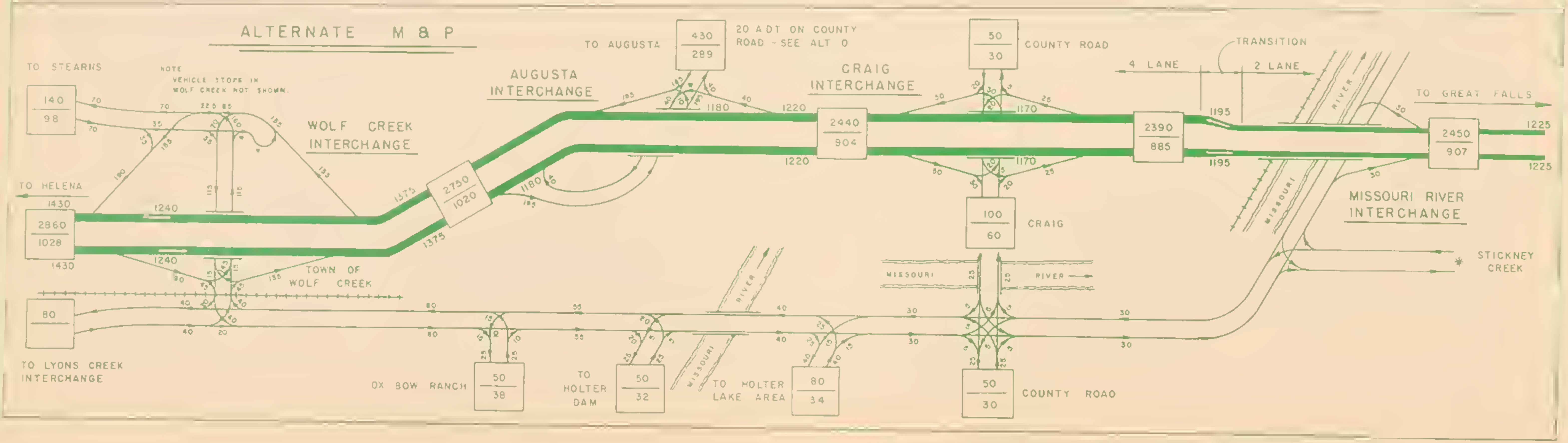
INTERSTATE 15 WOLF CREEK TO STICKNEY CREEK



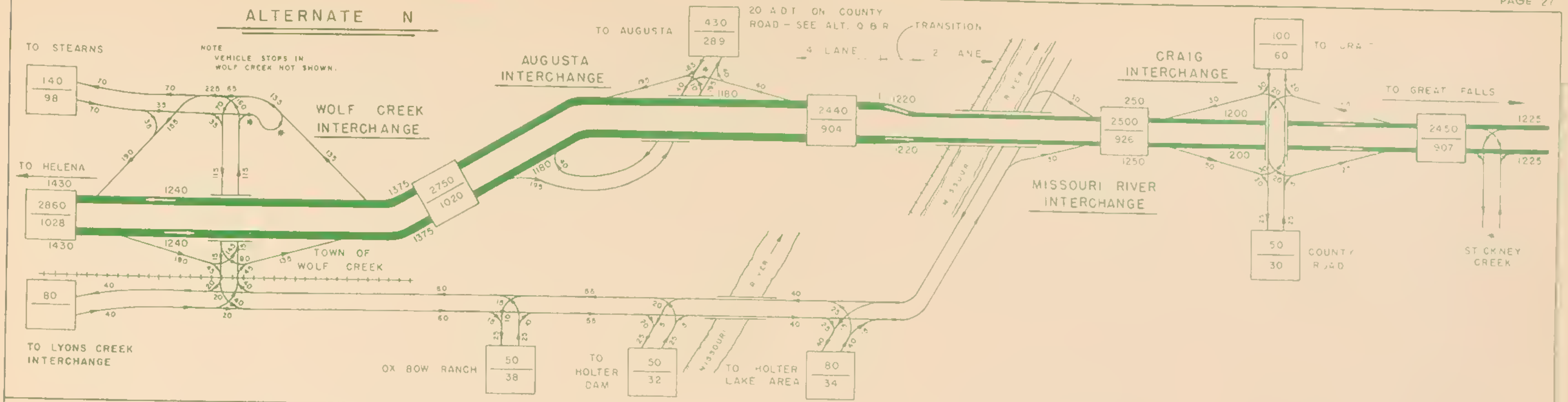
ALTERNATE O



ALTERNATE M & P



ALTERNATE N



ALTERNATE Q & R

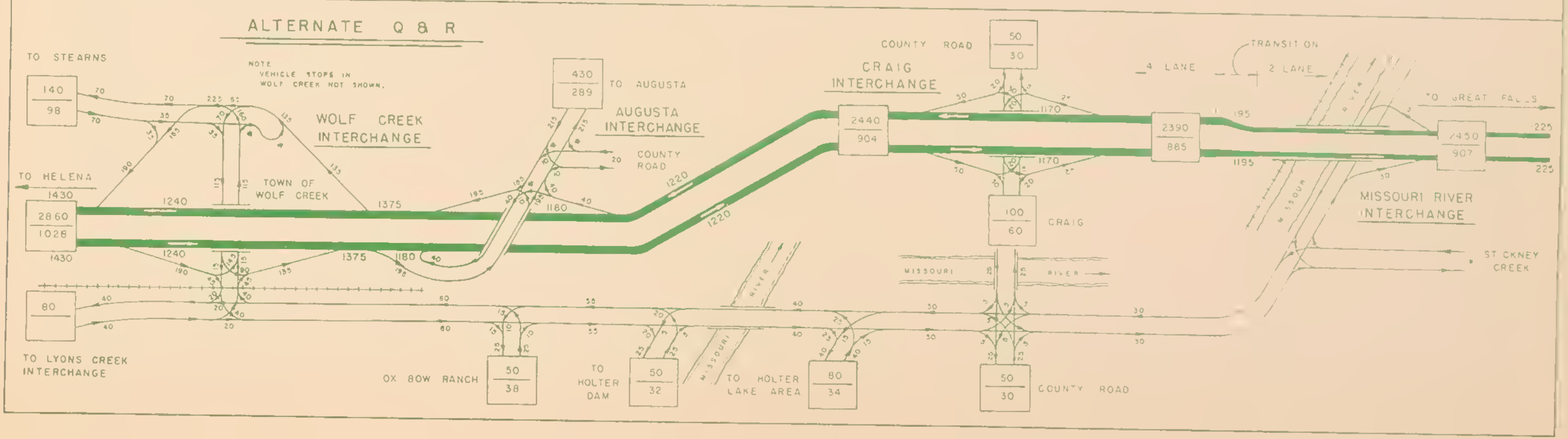


TABLE I
ANNUAL ROAD USERS COST

LOCATION AND DESCRIPTION		AVERAGE DAILY TRAFFIC									
		1958 ADT	1975 ADT	1972 ADT	Ap Passenger Cars 1972 ADT x 85%	At Trucks & Busses 1972 ADT x 15%	Ae Equiv. Veh. At x 3.5	A Tot. Vehicles Ap + Ae	U Unit Cost Dollars Mile	L Length Miles	Road Users Cost AxUxLx365 Dollars
LOCATION L											
Beginning of Project to Wolf Creek	—Interstate, 4 Lane, Paved, 0.3% Grade	1028	2860	2537	2156	381	1334	3490	0.0985	0.35	$ 43,916
Wolf Creek to Augusta Interchange	—Interstate, 4 Lane, Paved, 0.3% Grade	941	2540	2258	1919	339	1187	3106	0.0981	1.09	121,224
Augusta Interchange to Missouri River Interchange	—Interstate, 4 Lane, Paved, 0.3% Grade	904	2440	2169	1844	325	1138	2982	0.0958	2.39	249,209
Missouri River Interchange to 2 Lane Transition	—Interstate, 4 Lane, Paved, 0.3% Grade	926	2500	2222	1889	333	1166	3055	0.0954	2.20	234,032
Transition to Craig Interchange	—Interstate, 2 Lane, Paved, 0.3% Grade	926	2500	2222	1889	333	1166	3055	0.1152	2.73	350,687
Craig Interchange to End of Project	—Interstate, 2 Lane, Paved, 0.3% Grade	907	2450	2178	1851	327	1145	2996	0.1153	3.01	379,516
Augusta Road to Wolf Creek	—Primary, 2 Lane, Paved, 0.3% Grade		160	142	121	21	74	195	0.1185	1.08	9,109
Augusta Road to Augusta Interchange	—Primary, 2 Lane, Paved, 3.5% Grade	289	450	422	359	63	221	580	0.1185	0.89	22,327
Augusta Interchange to Holter Dam Road	—Frontage, 2 Lane, Gravel, 0.3% Grade		110	89	76	13	46	122	0.1272	2.39	13,537
											$1,423,557
LOCATION M											
Beginning of Project to Wolf Creek	—Interstate, 4 Lane, Paved, 0.3% Grade	1028	2860	2537	2156	381	1334	3490	0.0971	0.55	$ 68,030
Wolf Creek to Augusta Interchange	—Interstate, 4 Lane, Paved, 0.3% Grade	1020	2750	2445	2078	367	1285	3363	0.0981	1.48	178,218
Augusta Interchange to Craig Interchange	—Interstate, 4 Lane, Paved, 3.5% Grade	904	2440	2169	1844	325	1138	2982	0.0990	5.65	608,813
Craig Interchange to 2 Lane Transition	—Interstate, 4 Lane, Paved, 3.5% Grade	885	2390	2125	1806	318	1116	2922	0.0995	1.63	172,975
Transition to Missouri River Interchange	—Interstate, 2 Lane, Paved, 0.3% Grade	885	2390	2125	1806	318	1116	2922	0.1158	0.69	85,218
Missouri River Interchange to End of Project	—Interstate, 2 Lane, Paved, 0.3% Grade	907	2450	2178	1851	327	1145	2996	0.1153	0.79	99,607
Wolf Creek to Holter Dam Road	—Frontage, 2 Lane, Gravel, 0.3% Grade		110	89	76	13	46	122	0.1272	3.12	17,672
Holter Dam Road to Missouri River Interchange	—Frontage, 2 Lane, Gravel, 0.3% Grade		60	53	45	8	28	73	0.1272	7.18	24,335
											$1,254,868
LOCATION O											
Beginning of Project to Wolf Creek	—Interstate, 4 Lane, Paved, 0.3% Grade	1028	2860	2537	2156	381	1334	3490	0.0971	0.55	$ 68,030
Wolf Creek to Augusta Interchange	—Interstate, 4 Lane, Paved, 0.3% Grade	1020	2750	2445	2078	367	1285	3363	0.0957	1.21	142,140
Augusta Interchange to Missouri River Interchange	—Interstate, 4 Lane, Paved, 0.3% Grade	904	2440	2169	1844	325	1138	2982	0.0954	1.87	194,174
Missouri River Interchange to 2 Lane Transition	—Interstate, 4 Lane, Paved, 0.3% Grade	926	2500	2222	1889	333	1166	3055	0.0954	2.18	231,904
Transition to Craig Interchange	—Interstate, 2 Lane, Paved, 0.3% Grade	926	2500	2222	1889	333	1166	3055	0.1158	2.73	352,513
Craig Interchange to End of Project	—Interstate, 2 Lane, Paved, 0.3% Grade	907	2450	2178	1851	327	1145	2996	0.1153	3.01	379,516
Augusta Road to Augusta Interchange	—Primary, 2 Lane, Paved, 3.5% Grade	289	450	422	359	63	221	580	0.1185	0.52	13,045
Wolf Creek to Holter Dam Road	—Frontage, 2 Lane, Gravel, 0.3% Grade		110	89	76	13	46	122	0.1272	3.12	17,672
											$1,398,994
LOCATION R											
Beginning of Project to Wolf Creek	—Interstate, 4 Lane, Paved, 0.3% Grade	1028	2860	2537	2156	381	1334	3490	0.0971	0.55	$ 68,030
Wolf Creek to Augusta Interchange	—Interstate, 4 Lane, Paved, 0.3% Grade	1020	2750	2445	2078	367	1285	3363	0.0957	1.21	142,140
Augusta Interchange to Station 712+00	—Interstate, 4 Lane, Paved, 0.3% Grade	904	2440	2169	1844	325	1138	2982	0.0957	1.53	159,369
Station 712+00 to Craig Interchange	—Interstate, 4 Lane, Paved, 3.5% Grade	904	2440	2169	1844	325	1138	2982	0.0990	4.60	495,671
Craig Interchange to 2 Lane Transition	—Interstate, 4 Lane, Paved, 3.5% Grade	885	2390	2125	1806	318	1116	2922	0.0995	1.63	172,975
Transition to Missouri River Interchange	—Primary, 2 Lane, Paved, 0.3% Grade	885	2390	2125	1806	318	1116	2922	0.1158	0.69	85,218
Missouri River Interchange to End of Project	—Primary, 2 Lane, Paved, 0.3% Grade	907	2450	2178	1851	327	1145	2996	0.1153	0.79	99,607
Augusta Road to Augusta Interchange	—Primary, 2 Lane, Paved, 0.3% Grade	289	450	422	359	63	221	580	0.1185	0.52	13,045
Wolf Creek to Holter Dam Road	—Frontage, 2 Lane, Gravel, 0.3% Grade		110	89	76	13	46	122	0.1272	3.12	17,672
Holter Dam Road to Missouri River Interchange	—Frontage, 2 Lane, Gravel, 0.3% Grade		60	53	45	8	28	73	0.1272	7.18	24,335
											$1,278,062

TABLE I-Continued

ANNUAL ROAD USERS COST

LOCATION AND DESCRIPTION		1958 ADT	1975 ADT	1972 ADT	AVERAGE DAILY TRAFFIC Ap Passenger Cars 1972 ADT x 85%	At Trucks & Busses 1972 ADT x 15%	Ae Equiv. Veh. At x 3.5	A Tot. Vehicles Ap + Ae	U Unit Cost Dollars Mile	L Length Miles	Road Users Cost AxUxLx365 Dollars
LOCATION P											
Beginning of Project to Wolf Creek	—Interstate, 4 Lane, Paved, 0-3% Grade	1028	2860	2537	2156	381	1334	3490	0.0971	0.55	$ 68,030
Wolf Creek to Augusta Interchange	—Interstate, 4 Lane, Paved, 0-3% Grade	1020	2750	2445	2078	367	1285	3363	0.0981	1.48	178,218
Augusta Interchange to Station 840+00	—Interstate, 4 Lane, Paved, 3-5% Grade	904	2440	2169	1844	325	1138	2982	0.0990	3.52	379,296
Station 840+00 to Craig Interchange	—Interstate, 4 Lane, Paved, 0-3% Grade	904	2440	2169	1844	325	1138	2982	0.0962	2.32	242,920
Craig Interchange to 2 Lane Transition	—Interstate, 4 Lane, Paved, 0-3% Grade	885	2390	2125	1806	318	1116	2922	0.0971	1.67	172,945
Transition to Missouri River Interchange	—Interstate, 4 Lane, Paved, 0-3% Grade	885	2390	2125	1806	318	1116	2922	0.1158	0.69	85,218
Missouri River Interchange to End of Project	—Interstate, 4 Lane, Paved, 0-3% Grade	907	2450	2178	1851	327	1145	2996	0.1153	0.79	99,607
Wolf Creek to Holter Dam Road	—Frontage, 2 Lane, Gravel, 0-3% Grade		110	89	76	13	46	122	0.1272	3.12	17,672
Holter Dam Road to Missouri River Interchange	—Frontage, 2 Lane, Gravel, 0-3% Grade		60	53	45	8	28	73	0.1272	7.18	24,335
											$1,268,241
LOCATION Q											
Beginning of Project to Wolf Creek	—Interstate, 4 Lane, Paved, 0-3% Grade	1028	2860	2537	2156	381	1334	3490	0.0971	0.55	$ 68,030
Wolf Creek to Augusta Interchange	—Interstate, 4 Lane, Paved, 0-3% Grade	1020	2750	2445	2078	367	1285	3363	0.0957	1.21	142,140
Augusta Interchange to Station 712+00	—Interstate, 4 Lane, Paved, 0-3% Grade	904	2440	2169	1844	325	1138	2982	0.0957	1.53	159,369
Station 712+00 to Station 840+00	—Interstate, 4 Lane, Paved, 3-5%Grade	904	2440	2169	1844	325	1138	2982	0.0990	2.42	260,766
Station 840+00 to Craig Interchange	—Interstate, 4 Lane, Paved, 0-3% Grade	904	2440	2169	1844	325	1138	2982	0.0962	2.32	212,950
Craig Interchange to 2 Lane Transition	—Interstate, 4 Lane, Paved, 0-3% Grade	885	2390	2125	1806	318	1116	2922	0.0971	1.67	172,945
Transition to Missouri River Interchange	—Interstate, 2 Lane, Paved, 0-3% Grade	885	2390	2125	1806	318	1116	2922	0.1158	0.69	85,218
Missouri River Interchange to End of Project	—Interstate, 2 Lane, Paved, 0-3% Grade	907	2450	2178	1851	327	1145	2996	0.1153	0.79	99,607
Augusta Road to Augusta Interchange	—Primary, 2 Lane, Paved, 3-5% Grade	289	450	422	359	63	221	580	0.1185	0.52	13,045
Wolf Creek Road to Holter Dam Road	—Frontage, 2 Lane, Gravel, 0-3% Grade		110	89	76	13	46	122	0.1272	3.12	17,672
Holter Dam Road to Missouri River Interchange	—Frontage, 2 Lane, Gravel, 0-3% Grade		60	53	45	8	28	73	0.1272	7.18	24,335
											$1,287,047
LOCATION N											
Beginning of Project to Wolf Creek	—Interstate, 4 Lane, Paved, 0-3% Grade	1028	2860	2537	2156	381	1334	3490	0.0971	0.55	68,030
Wolf Creek to Augusta Interchange	—Interstate, 4 Lane, Paved, 0-3% Grade	1020	2750	2445	2078	367	1285	3363	0.0981	1.48	178,218
Augusta Interchange to Missouri River Interchange	—Interstate, 4 Lane, Paved, 3-5% Grade	904	2440	2169	1844	325	1138	2982	0.0995	2.96	320,564
Missouri River Interchange to Craig Interchange	—Interstate, 2 Lane, Paved, 0-3% Grade	926	2500	2222	1889	333	1166	3055	0.1158	3.26	420,950
Craig Interchange to End of Project	—Interstate, 2 Lane, Paved, 0-3% Grade	907	2450	2178	1851	327	1145	2996	0.1153	3.01	379,516
Wolf Creek to Holter Dam Road	—Frontage, 2 Lane, Gravel, 0-3% Grade		110	89	76	13	46	122	0.1272	3.12	17,672
Holter Dam Road to Missouri River Interchange	—Frontage, 2 Lane, Gravel, 0-3% Grade		60	53	45	8	28	73	0.1272	2.40	8,141
											$1,393,091
BASIC CONDITION											
Beginning of Project to Wolf Creek	—Primary, 2 Lane, Paved, 0-3% Grade	1028	2860	2537	2156	381	1334	3490	0.1234	0.66	$ 103,747
Wolf Creek to Ox Bow Ranch Area	—Primary, 2 Lane, Paved, 0-3% Grade	941	2540	2258	1919	339	1187	3106	0.1234	1.04	145,493
Ox Bow Ranch Area to Holter Dam Area	—Primary, 2 Lane, Paved, 0-3% Grade	904	2440	2169	1844	325	1138	2982	0.1273	2.09	289,584
Holter Dam Area to Station 2181+50	—Primary, 2 Lane, Paved, 0-3% Grade	926	2500	2222	1889	333	1166	3055	0.1328	2.40	355,397
Station 2181+50 to Craig Road	—Primary, 2 Lane, Paved, 0-3% Grade	926	2500	2222	1889	333	1166	3055	0.1289	2.83	406,766
Craig Road to End of Project	—Primary, 2 Lane, Paved, 0-3% Grade	907	2450	2178	1851	327	1145	2996	0.1289	2.90	408,776
Augusta Road to Wolf Creek	—Primary, 2 Lane, Paved, 3-5% Grade	289	450	422	359	63	221	580	0.1185	1.60	40,138
											$1,749,901

TABLE 2

ANNUAL CONSTRUCTION AND MAINTENANCE COST

Construction Costs at 4% Interest

Location	Item	Estimated Life Years	Total Cost Dollars	K	Annual Cost Dollars
L	Right of Way	50	[illegible]	0.0465	$ 26,911
	Grading and Drainage	40	[illegible]	0.0505	[illegible]
	Major Structures	50	[illegible]	0.0465	87,188
	Surfacing	20	[illegible]	0.0736	[illegible]
	Maintenance: Interstate 4-lane [illegible] miles @ $3,000 mile				18,090
	2-lane [illegible] miles @ $2,000 mile				11,480
	Primary 2-lane [illegible] miles @ $1,800 mile				2,880
	Frontage 2-lane [illegible] miles @ $ 200 mile				956
	Total				$363,212
M	Right of Way	50	[illegible]	0.0465	$ 16,782
	Grading and Drainage	40	[illegible]	0.0505	179,236
	Major Structures	50	1,255,000	0.0465	58,358
	Surfacing	20	[illegible]	0.0736	81,715
	Maintenance: Interstate 4-lane 9.31 miles @ $3,000 mile				27,930
	2-lane 1.48 miles @ $2,000 mile				2,960
	Frontage 2-lane 12.32 miles @ $ 200 mile				2,464
	Total				$372,445
N	Right of Way	50	[illegible]	0.0465	$ 18,195
	Grading and Drainage	40	[illegible]	0.0505	163,051
	Major Structures	50	1,270,000	0.0465	59,055
	Surfacing	20	[illegible]	0.0736	75,516
	Maintenance: Interstate 4-lane [illegible] miles @ $3,000 mile				[illegible]
	2-lane [illegible] miles @ $2,000 mile				[illegible]
	Frontage 2-lane [illegible] miles @ $ 200 mile				1,392
	Total				$334,602
O	Right of Way	50	[illegible]	0.0465	17,203
	Grading and Drainage	40	[illegible]	0.0505	145,238
	Major Structures	50	[illegible]	0.0465	93,698
	Surfacing	20	[illegible]	0.0736	83,050
	Maintenance: Interstate 4-lane [illegible] miles @ $3,000 mile				[illegible]
	4-lane [illegible] miles @ $2,000 mile				[illegible]
	Primary 2-lane [illegible] miles @ $1,800 mile				936
	Frontage 2-lane [illegible] miles @ $ 200 mile				966
	Total				$370,001

Location	Item	Estimated Life Years	Total Cost Dollars	*K	Annual Cost Dollars
P	Right of Way	50	461,747	0.0465	$ 21,471
	Grading and Drainage	40	3,773,407	0.0505	190,557
	Major Structures	50	1,260,000	0.0465	58,590
	Surfacing	20	1,229,388	0.0736	90,483
	Maintenance: Interstate 4-lane 9.54 miles @ $3,000 mile				28,620
	2-lane 1.48 miles @ $2,000 mile				2,960
	Frontage 2-lane 12.85 miles @ $ 200 mile				2,570
	Total				$395,251
Q	Right of Way	50	530,458	0.0465	24,666
	Grading and Drainage	40	4,200,657	0.0505	212,133
	Major Structures	50	1,155,000	0.0465	53,708
	Surfacing	20	1,199,805	0.0736	88,306
	Maintenance: Interstate 4-lane 9.70 miles @ $3,000 mile				29,100
	2-lane 1.48 miles @ $2,000 mile				2,960
	Primary 2-lane 0.52 miles @ $1,800 mile				936
	Frontage 2-lane 12.32 miles @ $ 200 mile				2,464
	Total				$414,273
R	Right of Way	50	425,073	0.0465	$ 19,766
	Grading and Drainage	40	3,859,776	0.0505	194,919
	Major Structures	50	1,150,000	0.0465	53,475
	Surfacing	20	1,136,832	0.0736	83,671
	Maintenance: Interstate 4-lane 9.52 miles @ $3,000 mile				28,560
	2-lane 1.48 miles @ $2,000 mile				2,960
	Primary 2-lane 0.52 miles @ $1,800 mile				936
	Frontage 2-lane 11.10 miles @ $ 200 mile				2,220
	Total				386,507

*K — Capital Recovery Factor

Maintenance for Basic Conditions	Amount
11.91 miles @ $1,800 mile =	$ 21,438
1.60 miles @ $1,800 mile =	2,880
	$ 24,318

TABLE 3

BENEFIT COST RATIO

$$\text{Benefit Ratio} = \frac{[\text{Annual road user cost for the Basic Condition}]-[\text{Annual road user cost for the Alternate Condition}]}{[\text{Annual construction cost for the Alternate Condition}]-[\text{Annual maintenance cost for the Basic Condition}]}$$

$$\text{LOCATION L over BASIC CONDITION} = \frac{1{,}749{,}901-1{,}423{,}557}{363{,}212-24{,}318} = \frac{326{,}344}{338{,}894} = 0.963$$

$$\text{LOCATION M over BASIC CONDITION} = \frac{1{,}749{,}901-1{,}254{,}868}{372{,}443-24{,}318} = \frac{495{,}033}{348{,}125} = 1.422$$

$$\text{LOCATION N over BASIC CONDITION} = \frac{1{,}749{,}901-1{,}393{,}091}{344{,}602-24{,}318} = \frac{356{,}810}{320{,}284} = 1.114$$

$$\text{LOCATION O over BASIC CONDITION} = \frac{1{,}749{,}901-1{,}398{,}994}{370{,}001-24{,}318} = \frac{350{,}907}{345{,}683} = 1.015$$

$$\text{LOCATION P over BASIC CONDITION} = \frac{1{,}749{,}901-1{,}268{,}241}{395{,}251-24{,}318} = \frac{481{,}660}{370{,}933} = 1.299$$

$$\text{LOCATION Q over BASIC CONDITION} = \frac{1{,}749{,}901-1{,}287{,}047}{414{,}273-24{,}318} = \frac{462{,}854}{389{,}955} = 1.187$$

$$\text{LOCATION R over BASIC CONDITION} = \frac{1{,}749{,}901-1{,}278{,}062}{386{,}507-24{,}318} = \frac{471{,}839}{362{,}189} = 1.303$$

TABLE 4

SUMMARY OF ALL COSTS FOR ALTERNATE LOCATIONS PROPOSED

	L	M	N	O	P	Q	R
ANNUAL CONSTRUCTION COST	329,806	339,089	315,600	339,189	361,101	378,813	351,831
ANNUAL MAINTENANCE COST	33,406	33,354	29,002	30,812	34,150	35,460	34,676
ANNUAL OPERATING COST	1,423,557	1,254,868	1,393,091	1,398,994	1,268,241	1,287,047	1,278,062
TOTAL OF ALL COSTS	1,786,769	1,627,311	1,737,693	1,768,995	1,663,492	1,701,320	1,664,569
ANNUAL SAVINGS IN FAVOR OF M LOCATION	159,458	———	110,382	141,684	36,181	74,009	37,258

Miscellanous Considerations

Maintenance of Traffic

The cost to the highway contractor for maintaining passage and detours through the area under construction is a very real expense. It will appear in construction bids as a maintenance of traffic item, if used, or else be reflected in higher unit bid prices and is directly related to the distance involved.

For this project, the cost of maintenance of traffic was considered great enough to bear consideration. Alternate L, on the east side of the Missouri River, would result in almost complete obliteration of the entire existing highway, and would create the greatest disruption of traffic service. The magnitude of this item varies between that for Line L and Lines M, P, Q and R. This item is listed in Figure 201.

The counterpart of the expense discussed above is the additional vehicle operation cost to the road user from traveling on roads under construction. This higher operating cost per mile considers stops, longer travel time, more vehicle and tire wear, lower gear operation, etc. This expense is not incorporated into the construction cost summary or the road user benefit analysis, but should be considered in location selection.

This cost to the public for the 1962 ADT on Location L would be $347 per day. Location O would affect State Highway 287 as well as U. S. 91, and its cost would be $228 per day. Alternate N would be somewhat less with a cost of $186 per day. Alternates M, P, Q and R will offer the least cost to the road user with $3 per day.

This expense is computed by multiplying the difference between the present road users cost per mile and the road users cost on a detour type roadway per mile, times the number of affected miles and the daily 1962 ADT. For this comparison it is assumed that all portions involving interruption of normal traffic operation for any one alternate would be under construction simultaneously. On the assumption that the interruption period would be 365 days for all lines, the additional cost of vehicle operation to the road user on Alignment L, over and above the equivalent cost on the recommended Location M, would be $125,560. The proportion of cost differential between these two lines would be even greater if construction schedules and duration of interruption of service for all Alternates were worked out in detail. This is an additional item which, from a cost standpoint, makes Alternate L and O more unfavorable.

Access

The access control of Interstate highways is governed by the law which established the system and set the standards. It is one of the outstanding built-in safety features of these roads. Random access, turning, and parking are not permitted and the right-of-way limits are fenced. Access can be made only at interchanges. This characteristic has a direct bearing on the present and potential utilization of the valley.

Access costs include the expense of construction required to build access roads to areas which can no longer be served by present facilities due to the alignment and access control of a new highway. In many instances present rural access facilities are not of a high type and new access roads of a similar type can be provided at low cost. In other areas cost of an access road may be higher than the value of the land to be served and the purchase of the land segregated is the most economical solution. Under other conditions it may be less costly to make a monetary settlement for present and future access rights with the property owner involved rather than to provide access.

Without specific provision for construction of sections of access road, the present county road from the Augusta Highway, 1.5 miles northeast of Wolf Creek, to Craig would be interrupted by the alternate lines on the west side of the Missouri River.

The continuity of this road should be maintained because it is a county road and it provides the only access to the land owners in this area. In order to maintain this access, a grade separation near Rock Creek will be required. The proposed location for this grade separation is the most economical. On the northwesterly side of the proposed alternates in this area, the county road will have to be reconstructed from the grade separation to the existing Augusta Highway. This section would follow the east-west section line which would be the shortest route, therefore, the least costly. The connection to the Augusta Highway would be north of its present connection and would keep this traffic away from the immediate ramp terminals of the trumpet interchange on the Augusta Road. On the southeasterly side of the Interstate the reconstructed county road would proceed from the grade separation northeasterly and parallel with the Interstate across Rock Creek to where a connection to the existing county road is possible. The drainage pipe proposed under the Interstate at Rock Creek will be lengthened to facilitate this crossing. The standard of the reconstructed roadway will be equal to or better than the existing conditions.

Alternates M, P, Q and R pass through a farm one mile north of Craig. The costs involved will be from one of three alternates; a direct damage settlement, a building relocation with a small settlement, or the construction of an underpass. The choice of which alternate will be used will be settled in negotiations made between the property owner and the Right-of-Way Department. However, these alternates will be reasonably close in cost and the average of the three are incorporated in the Cost Summary, Figure No. 201, listed under Right-of-Way.

One half mile south of Craig, Alternates P and Q will segregate a cultivated parcel of land. An estimate has been computed for the cost of an underpass at this location. However, since there will be access to this area for stock by use of the large drainage structure in Dog Creek, it is possible that damages to this property could be less than that of an underpass. This will be a right-of-way consideration. Adequate costs have been added to the cost summary for this item.

Along Alternate L there would be necessary limited frontage roads to facilitate access to agricultural areas and to allow use of a roadway to a Mountain States Telephone Company microwave site.

With Alignments L, O and N on the east side, there would be no other general access road near the river, for the present highway would no longer exist and a continuous frontage road would be too costly to construct. On all other alternates, all of the existing highway will remain. Thus the public will be afforded relatively easy and safer access to the river. In effect, Location M will preserve the present land use and access in the valley.

The total access costs on each alternate location are shown in the section Basis for Cost Estimates and added into the item Right-of-Way in the section Cost Summary and Comparison of Alternate Locations.

Utilities Adjustments

The expense involved in relocation of utilities was arrived at through discussion with the respective companies involved. Trunk telephone line relocation is based on $700 and $1,000 per pole for moderate and difficult relocations, respectively. Many of the poles that will have to be relocated will be to more difficult, rocky construction sites. There are between 40 and 55 poles per mile. The relocation of the trunk telephone line will be predominately in the area near Wolf Creek.

Construction costs for 7.2 K.V.A. and 100 K.V.A. Montana Power electric line relocation will vary from $100 to $1,000 per pole or structure. These lines would be intercepted on all alternate locations.

All alternates would have generally the same costs, and in comparison with the aggregate construction costs they will be moderate.

Right of Way

The limits of right-of-way for the purpose of estimating quantities were established as follows:

2 Lane	200 feet minimum width
4 Lane, Narrow Median	232 feet minimum width
4 Lane, Wide Median	270 feet minimum width

For sections exceeding these widths, the limit was set at ten feet beyond the toes of embankment slopes and tops of excavation backslopes.

Crop values and average market prices for crops grown on the various types of farming land within the studied area were obtained from the Montana Crop and Livestock Reporting Service. From these prices, extrapolation formed an estimated acreage value on these types of property. Property values, thus obtained, were modified and used as estimated purchase costs. Values assigned to rural property range from $25 per acre for the very poorest grazing land to $400 per acre for the best cultivated bottom land.

The major portion of right-of-way expense is for land and property located within the town of Wolf Creek, where some business properties are traversed. All alignments other than Alternate L are located on the north side of the railroad in the town and have the same right-of-way expense within the limits of the town. The location of Alternate L is largely on the south side of the railroad within the limits of the town. The land and property cost for the L location within the town is approximately two and and one-half times that for the other lines within the town.

Basis for Cost Estimates

An estimate as complete and detailed as possible and within the realm of accuracy warranted by a preliminary engineering report was prepared for each alternate location of this study. The cost summary appears as Figure No. 201 and compares the various alternates. The totals in this figure do not include allowance for engineering and contingencies. However, in Figure No. 203, in which the recommended alignment is scheduled, an item in the amount of 10% of the total construction cost has been added for construction, engineering and contingencies.

Excavation costs vary directly with the amount of rock excavation anticipated. The costs range from $0.32 to $1.25 per yard for dirt and solid rock, respectively. These prices include watering and rolling. A careful geologic inspection with engineering construction procedures in mind was made of all locations considered. From this examination, areas of different per-yard excavation costs were established. These unit prices are generally based on the summary of 1960 and 1961 average low bid prices on the projects contracted by the Highway Commission.

The surfacing sections used on all alignments were altered with respect to the stability of the subbase. The surfacing section in an area with a rocky subbase will be more capable of withstanding roadway pressures without deformation than will areas of dirt embankment. In these rock subbase areas a savings in base surfacing is sanctioned. The gravel weight for surfacing was computed at 3200 pounds per cubic yard. Bituminous material use and application rates are in accordance with present Montana State Highway Department practice.

A summary of bridge costs for all alternates appears on Figure No. 202. A lump sum price of $10,000 per interchange and $500 per roadway transition for signing and lighting has been used. Culvert lengths for the estimate were determined from the cross sections of the proposed roadway embankment at the point of crossing. Shoulder guard rail is figured on all embankment slopes exceeding 10 feet in height. Barrier guard rail in the median strip of 4-lane narrow median roadway will consist of single posts and double rails. As indicated in Figure 23, the unit price used for barrier guard rail is twice that for shoulder guard rail. Type C. W. Standard Interstate Fencing was computed on the center line length for two sides continuous at $8.00 per rod. The amount for bin type retaining wall is listed as "Retaining Wall." The unit cost of $9.00 per square foot includes the excavation for the bin wall and special backfill material where needed.

Access costs, utility adjustments and right-of-way costs were discussed in a previous section of this report and are listed as lump sums in the Cost Estimate. In the summary of Figure 201 these costs are combined under the heading of Right-of-Way. The breakdown of these totals is listed below:

Alternate	Access Costs	Utilities Relocation	Land and Property	Right-of-Way Total
L	98,010	52,300	428,418	578,728
M	79,000	59,000	222,901	360,901
N	89,710	55,800	245,775	391,285
O	76,010	39,500	254,451	369,961
P	104,000	54,600	303,147	461,747
Q	124,000	38,100	368,348	530,448
R	99,000	42,500	283,573	425,073

Construction Sections

It is recommended that this project be divided into seven construction sections. This will make the construction available to a larger number of contractors and should bring more competitive bid prices. The division recommended is as follows:

Section 1—Bridges in Section2. It is proposed that this section be let first. It contains bridges numbered PW30, PW40 and PW60.

Section 2—Beginning of Project to Station 660+00. This section includes all construction within the above limits exclusive of bridges. It is proposed that this section and Section 1 (the bridges in this section) be completed first, since it is usable as a unit without the remainder of the project.

Section 3—Bridge over Missouri River. This is a long bridge and will take considerable time for construction. Therefore, it must be let far enough ahead of the adjacent sections that completion dates will be approximately the same.

Section 4—Bridges in Section 5 excluding the Missouri River Crossing. This section will contain bridges numbered PW 105, PW 135, PW 145 and PE 170.

Section 5—Station 920+00 to End of Project. This section includes all construction within the above limits exclusive of bridges and surfacing.

Section 6—Station 660+00 to Station 920+00. This section has no bridges and it is proposed to be let without surfacing. It will probably be the fastest section to construct, although it will be useless until the completion of Sections 3, 4 and 5.

Section 7—Surfacing of Sections 5 and 6. This section should be the last section constructed.

A cost summary showing the seven recommended construction sections is shown in Figure No. 203.

DIVISION 2

ALTERNATE LOCATION M

PLAN AND PROFILE - FIGURE 1 THROUGH FIGURE 21
TYPICAL ROAD SECTIONS - FIGURES 22 AND 23
GEOLOGY MAP - FIGURES 24 AND 25
STRUCTURES - FIGURE 26 THROUGH FIGURE 32

FIGURE 1

RECOMMENDED LOCATION M

FIGURE 2 THROUGH FIGURE 21

LEGEND

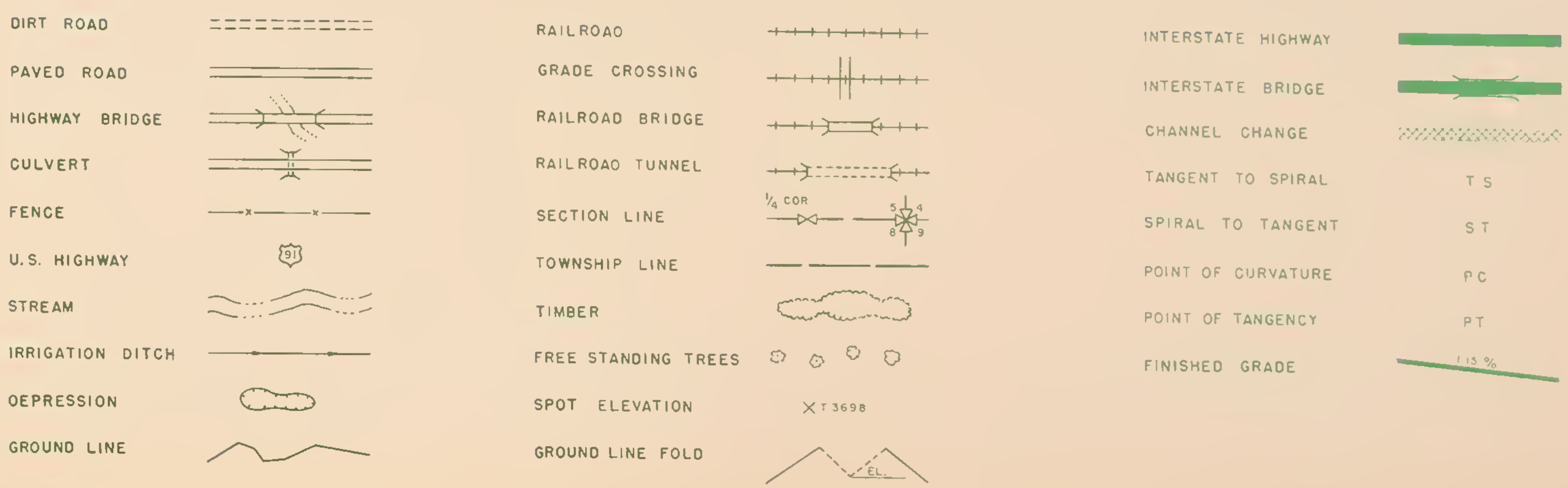
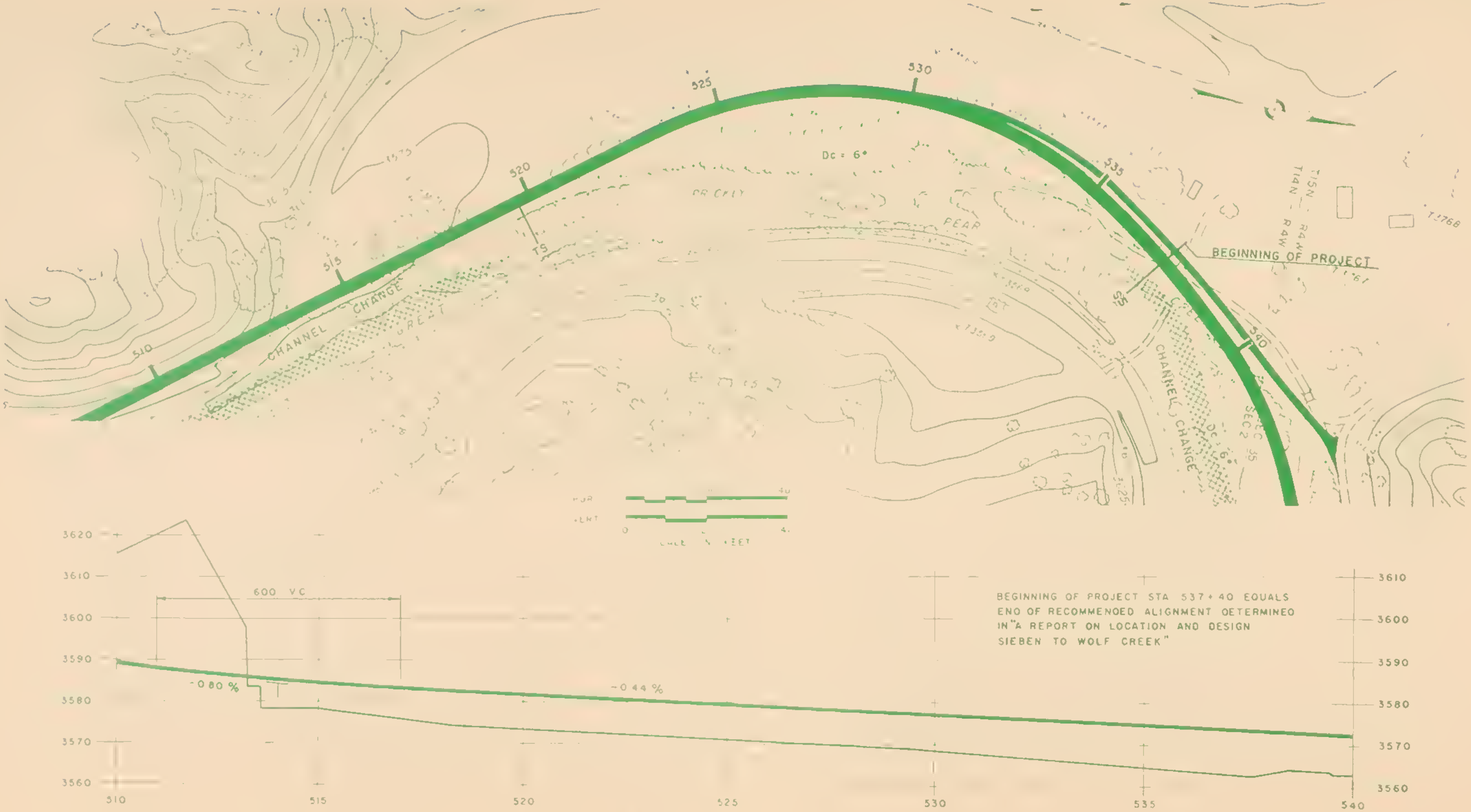
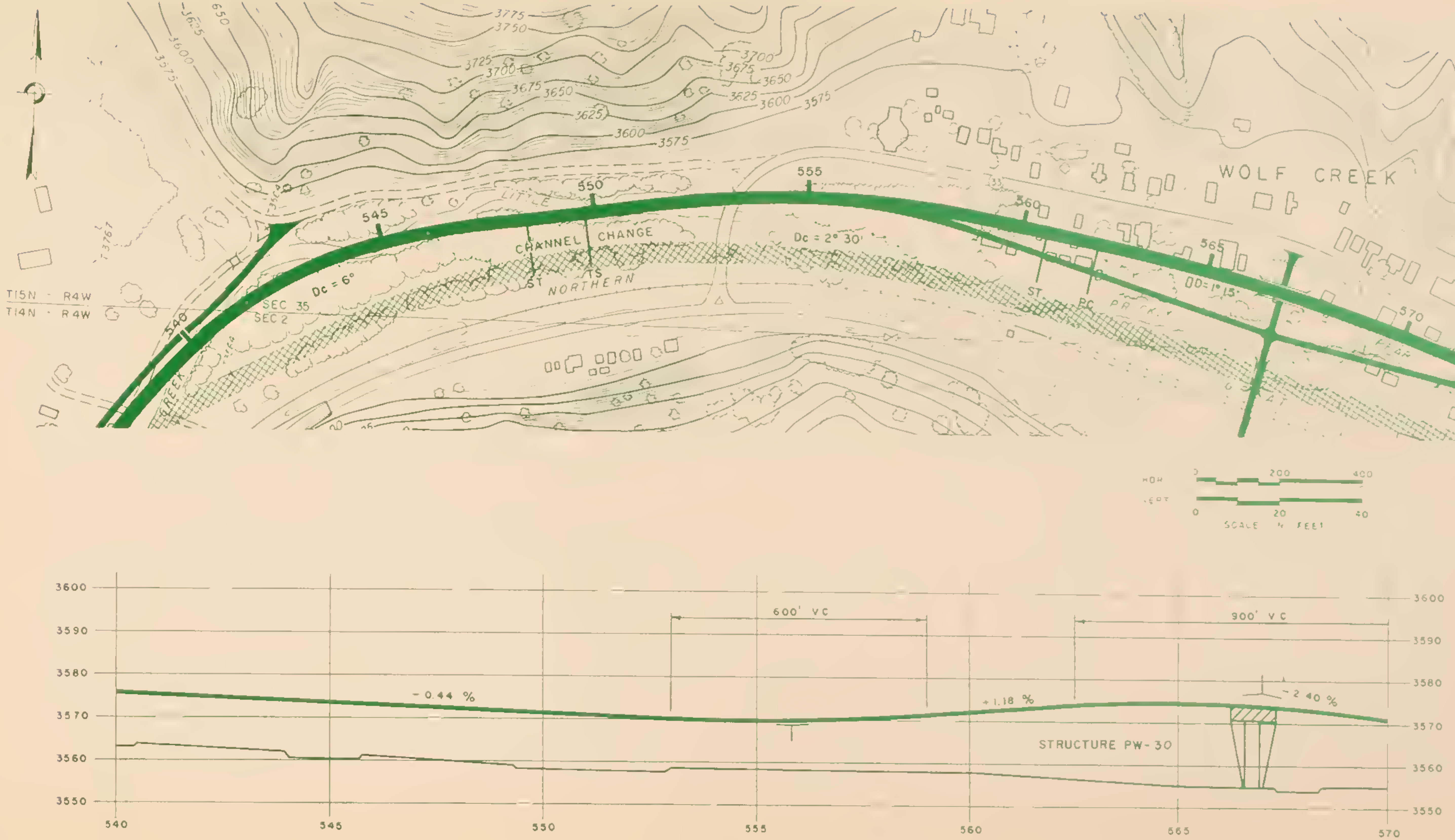


FIGURE 2



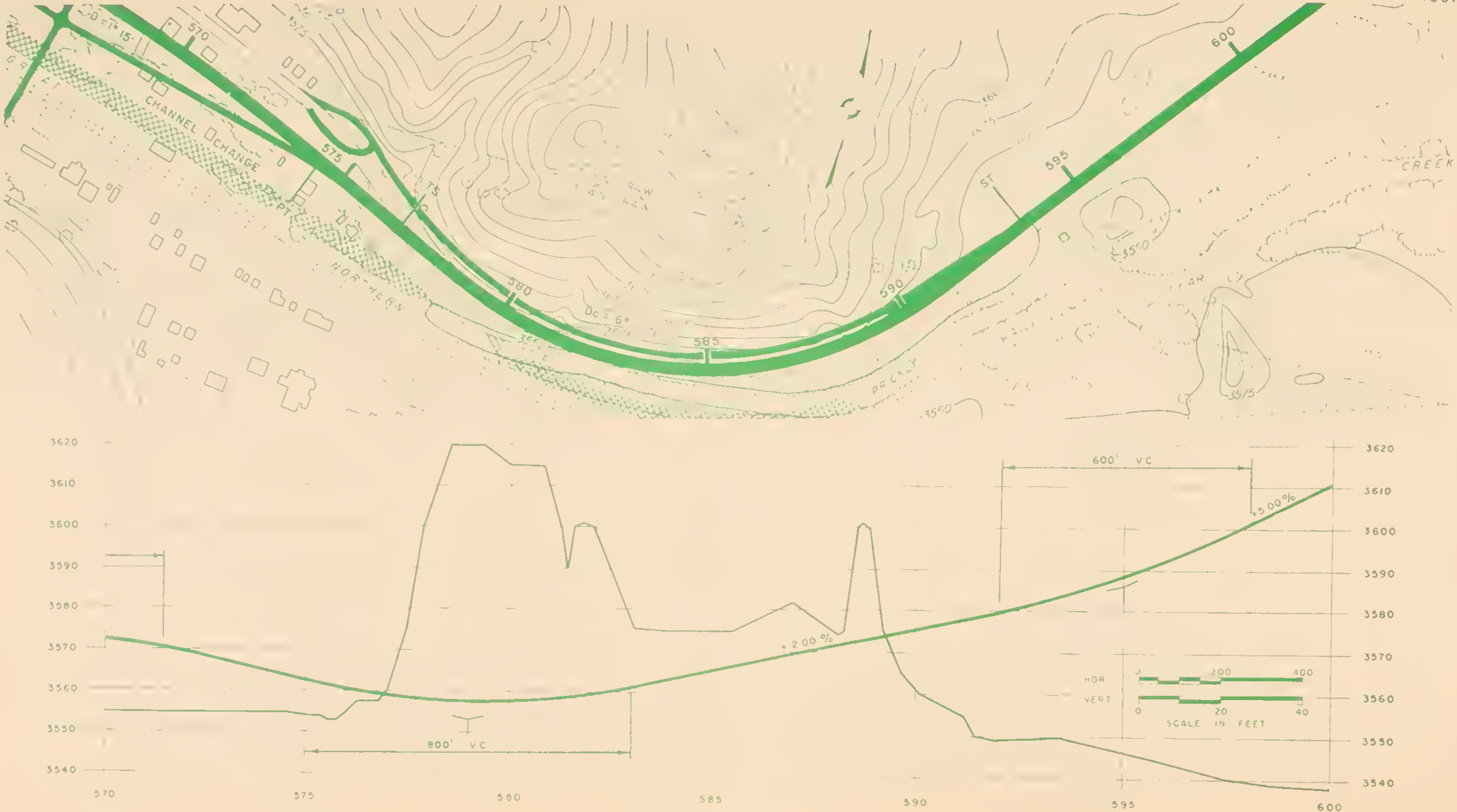
PLAN — PROFILE

FIGURE 3



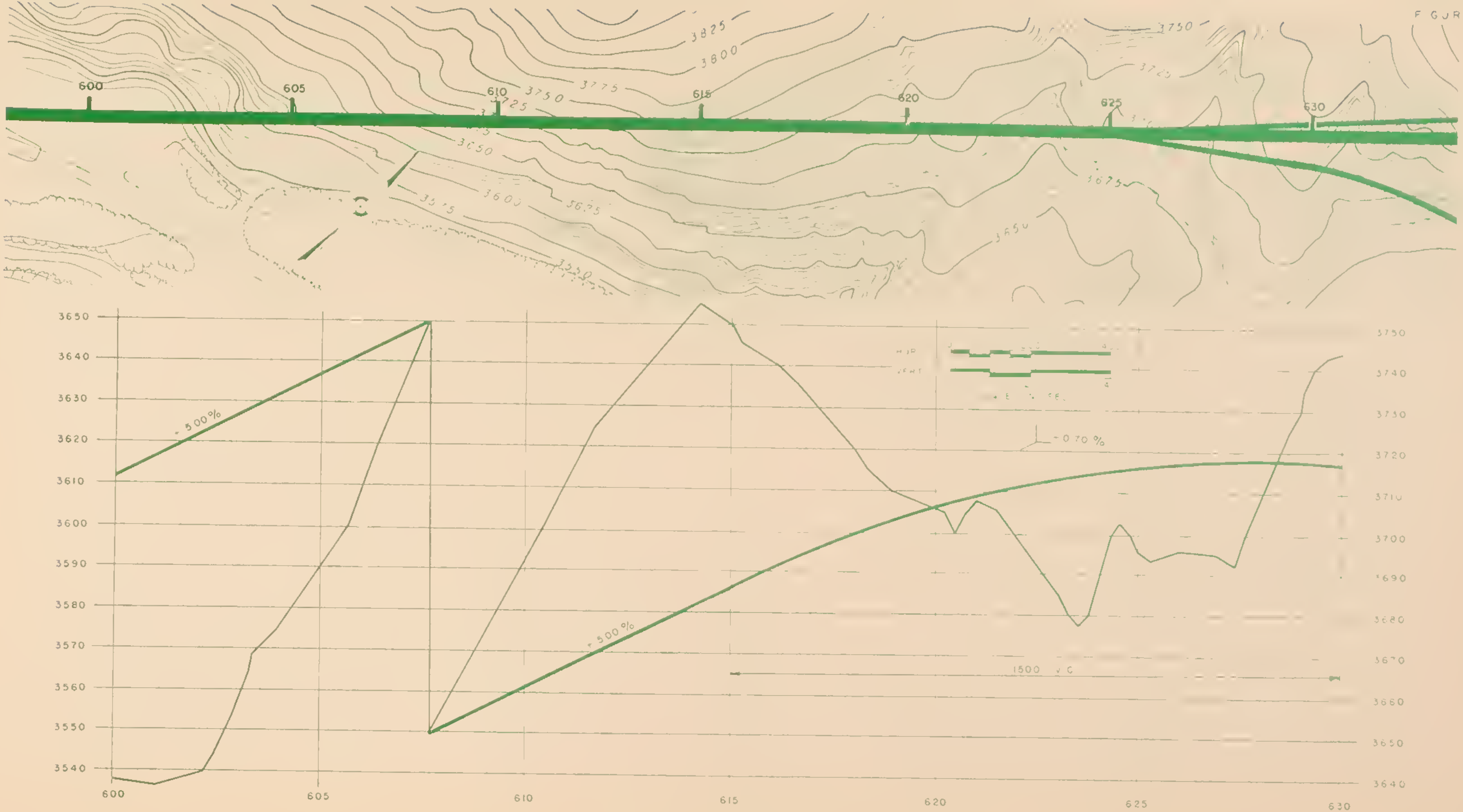
PLAN - PROFILE

FIGURE 4



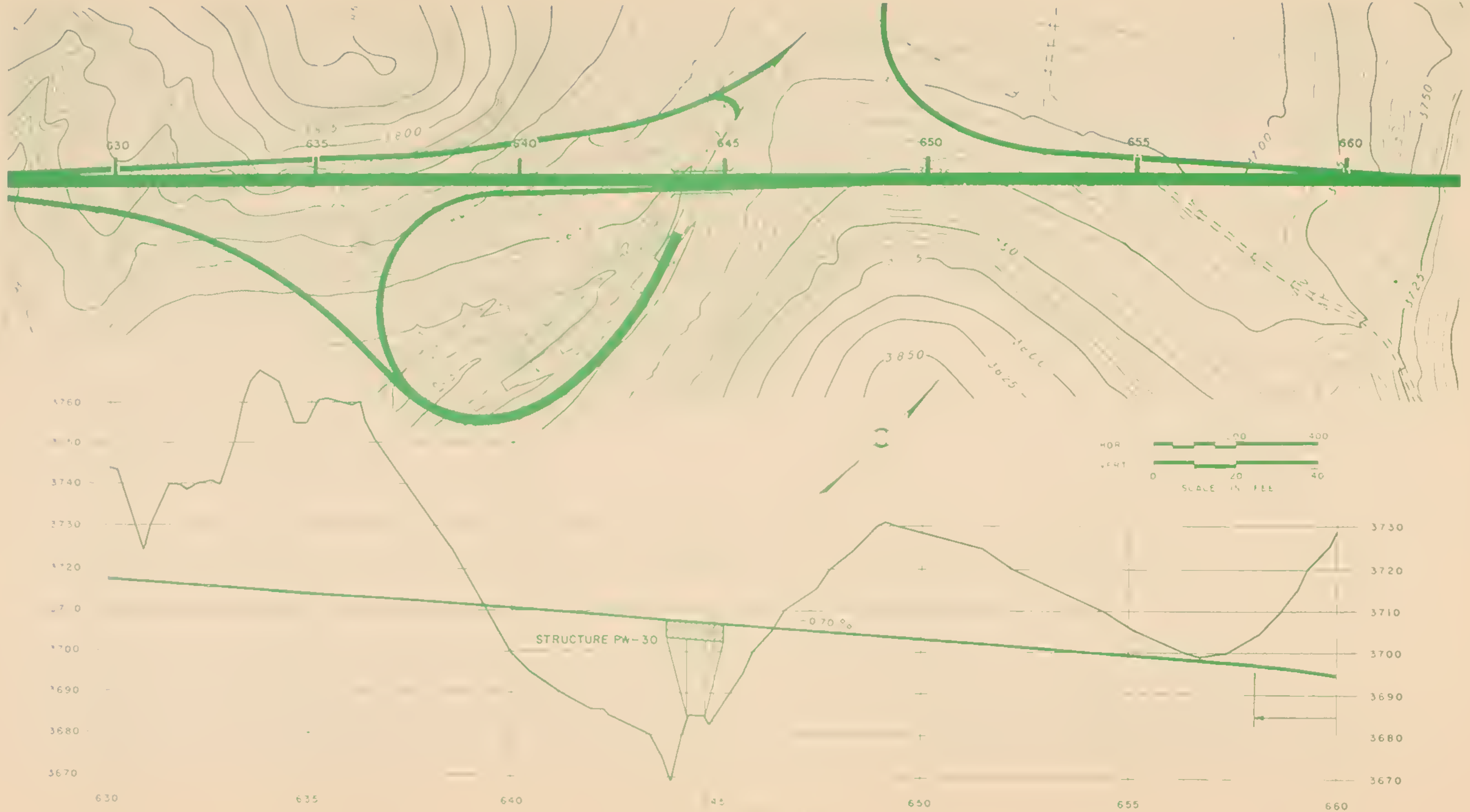
PLAN — PROFILE

FIGURE 5



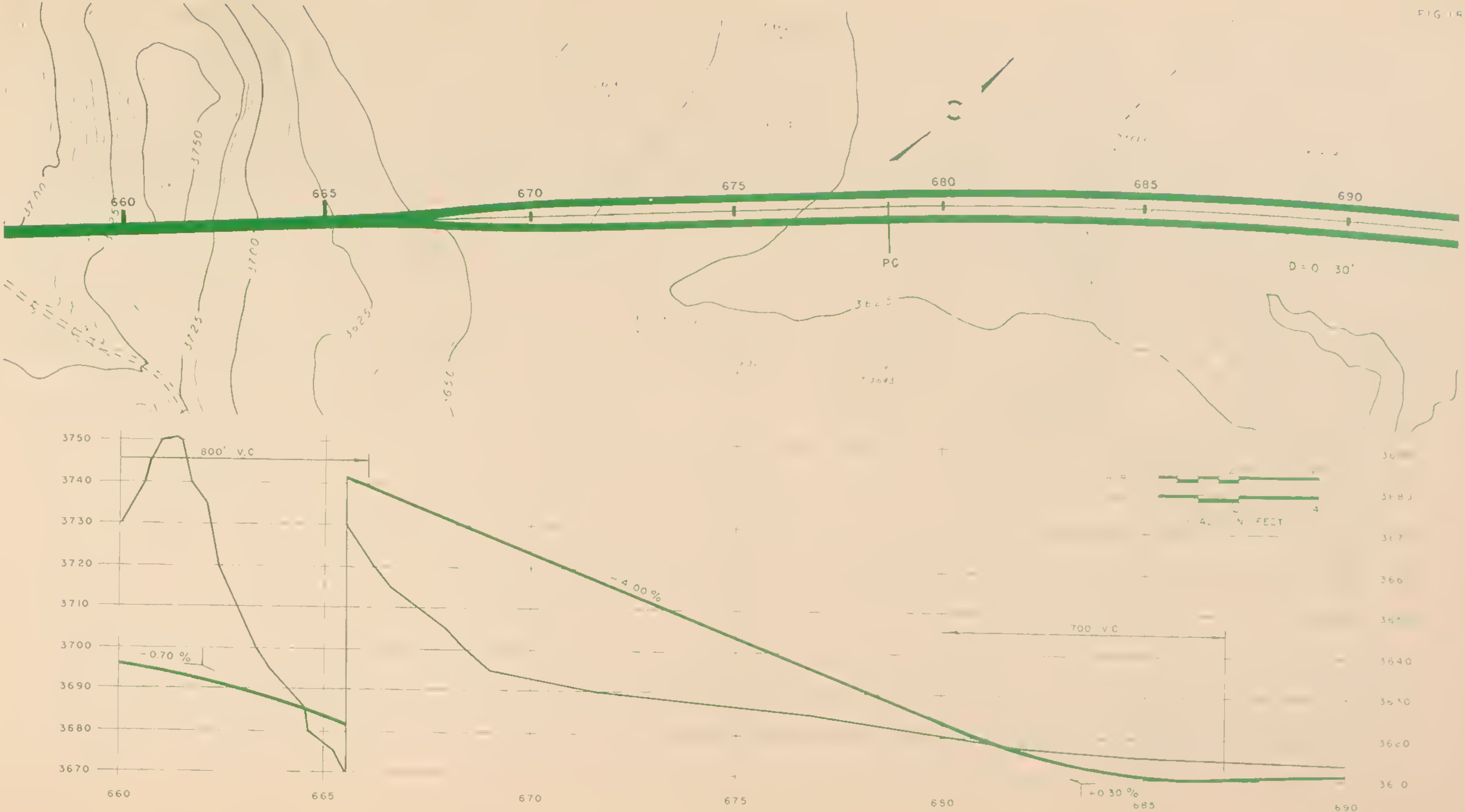
PLAN — PROFILE

FIGURE 6



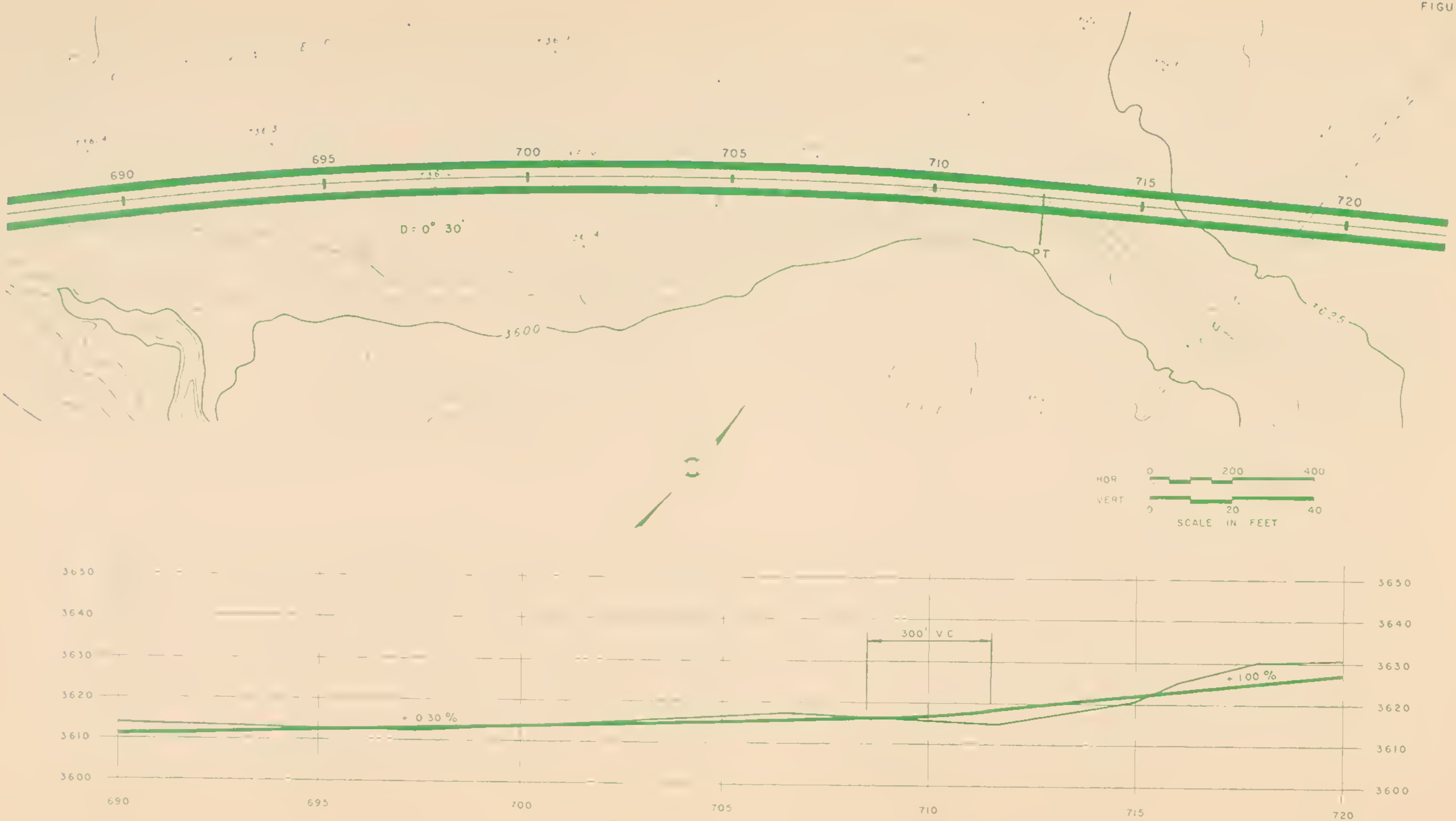
PLAN AND PROFILE

FIGURE 7



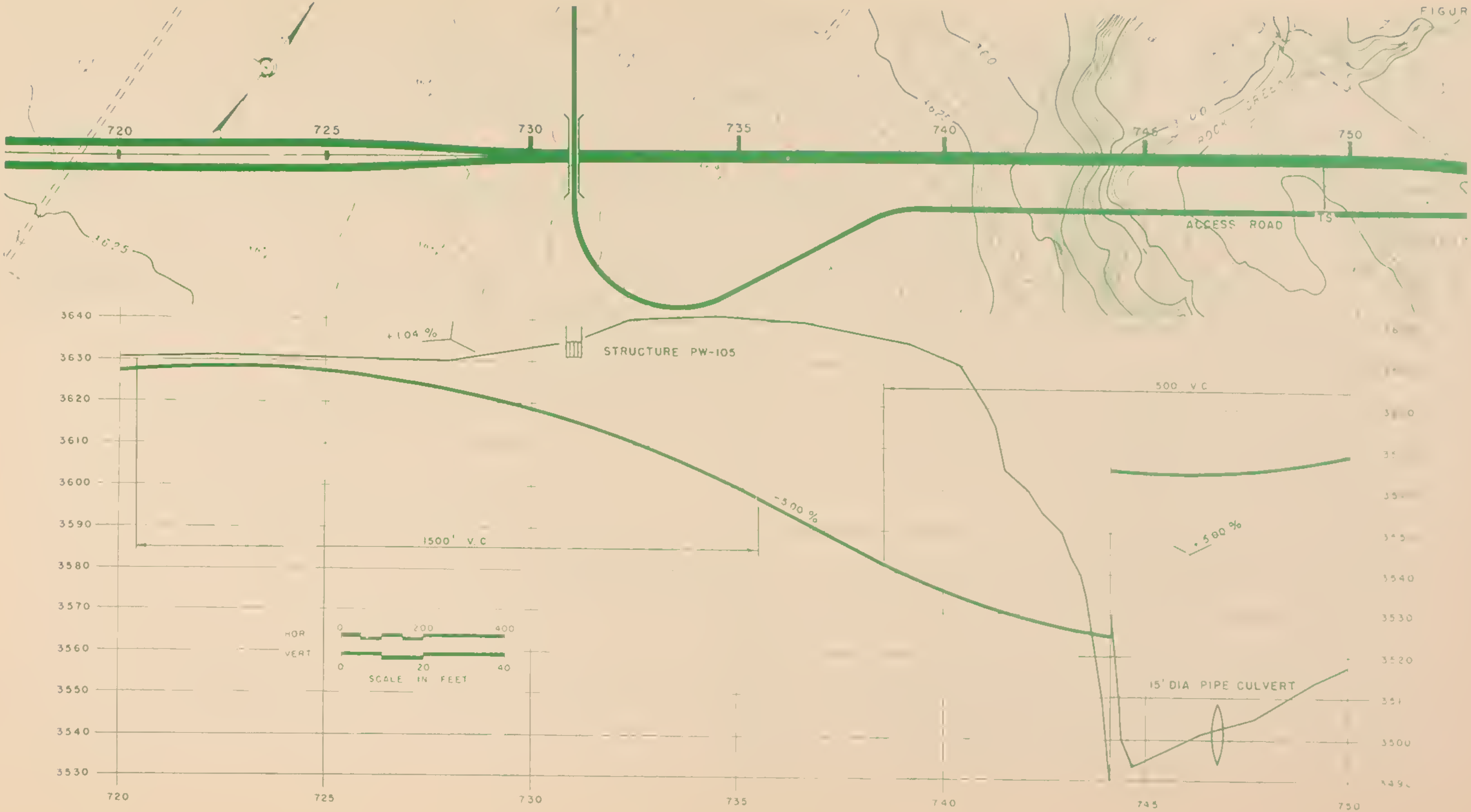
PLAN - PROFILE

FIGURE 8



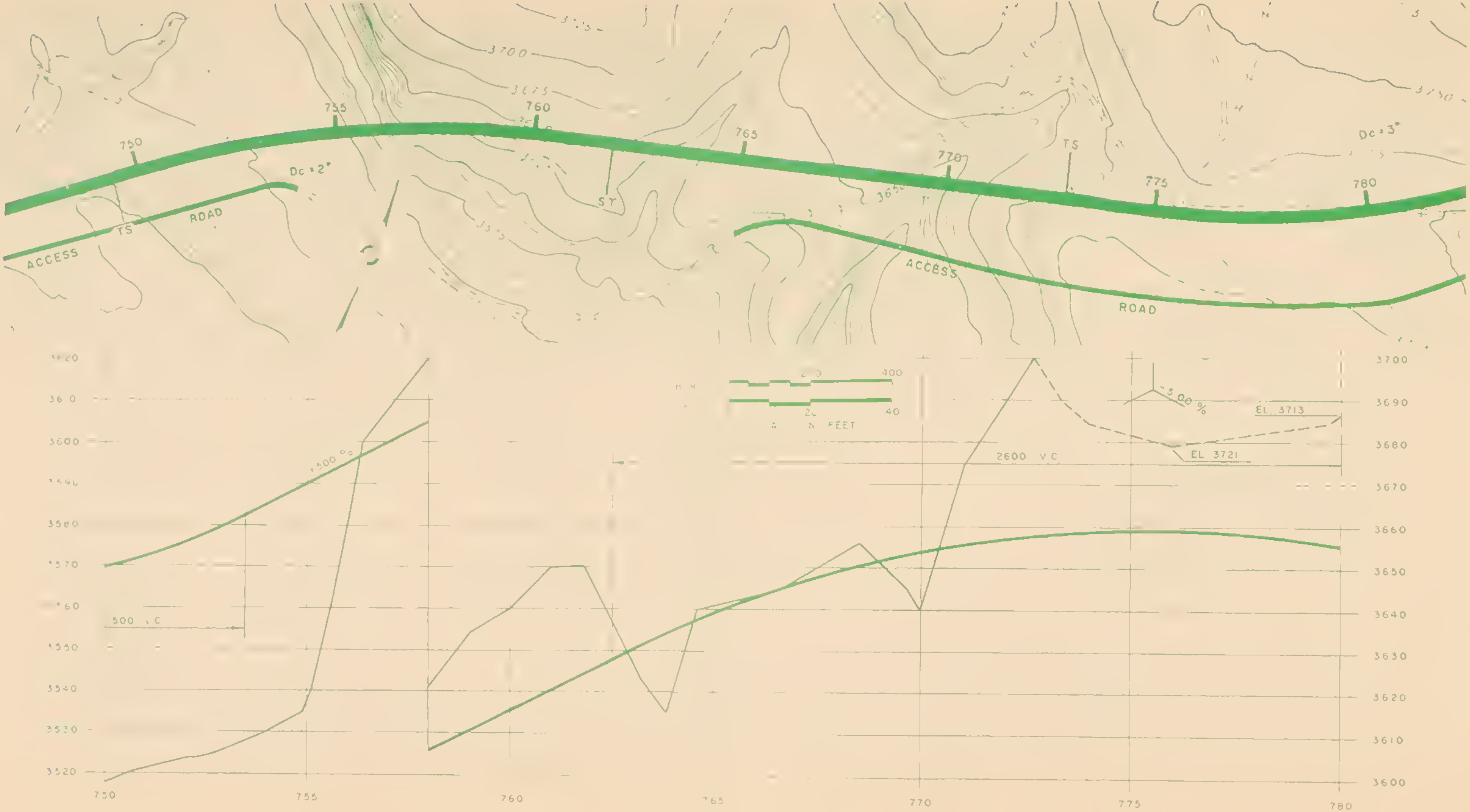
PLAN - PROFILE

FIGURE 9



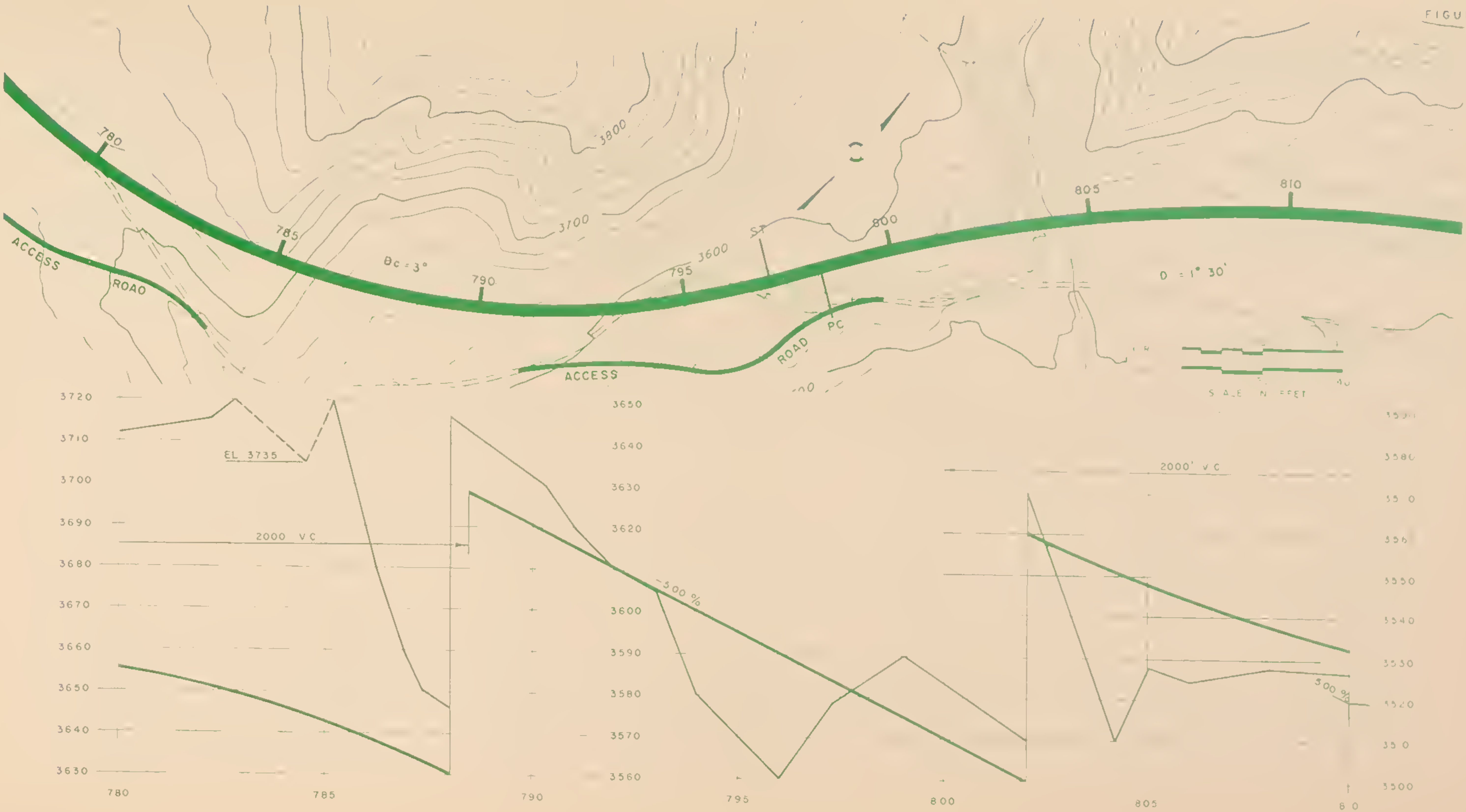
PLAN — PROFILE

FIGURE 10



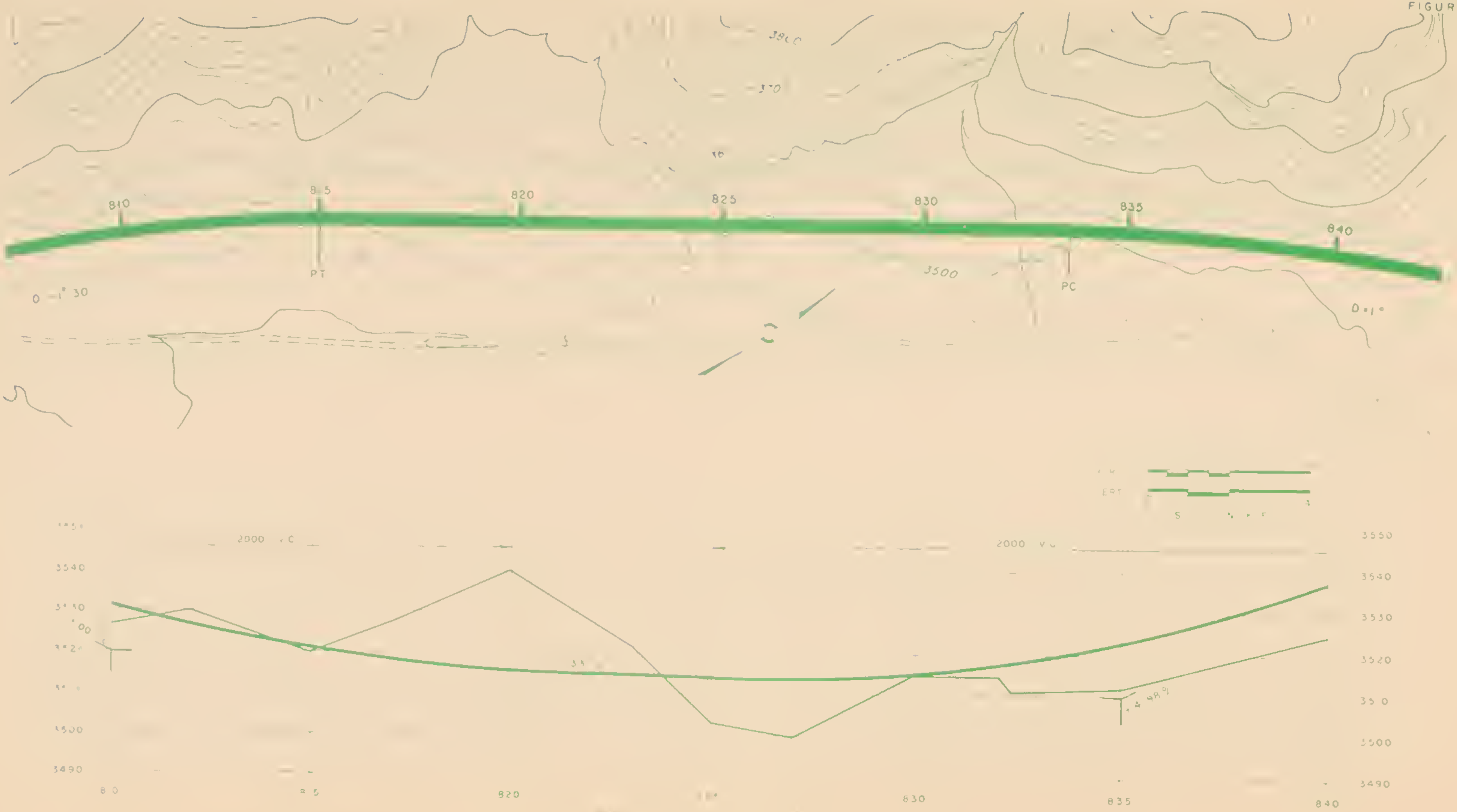
PLAN – PROFILE

FIGURE 11



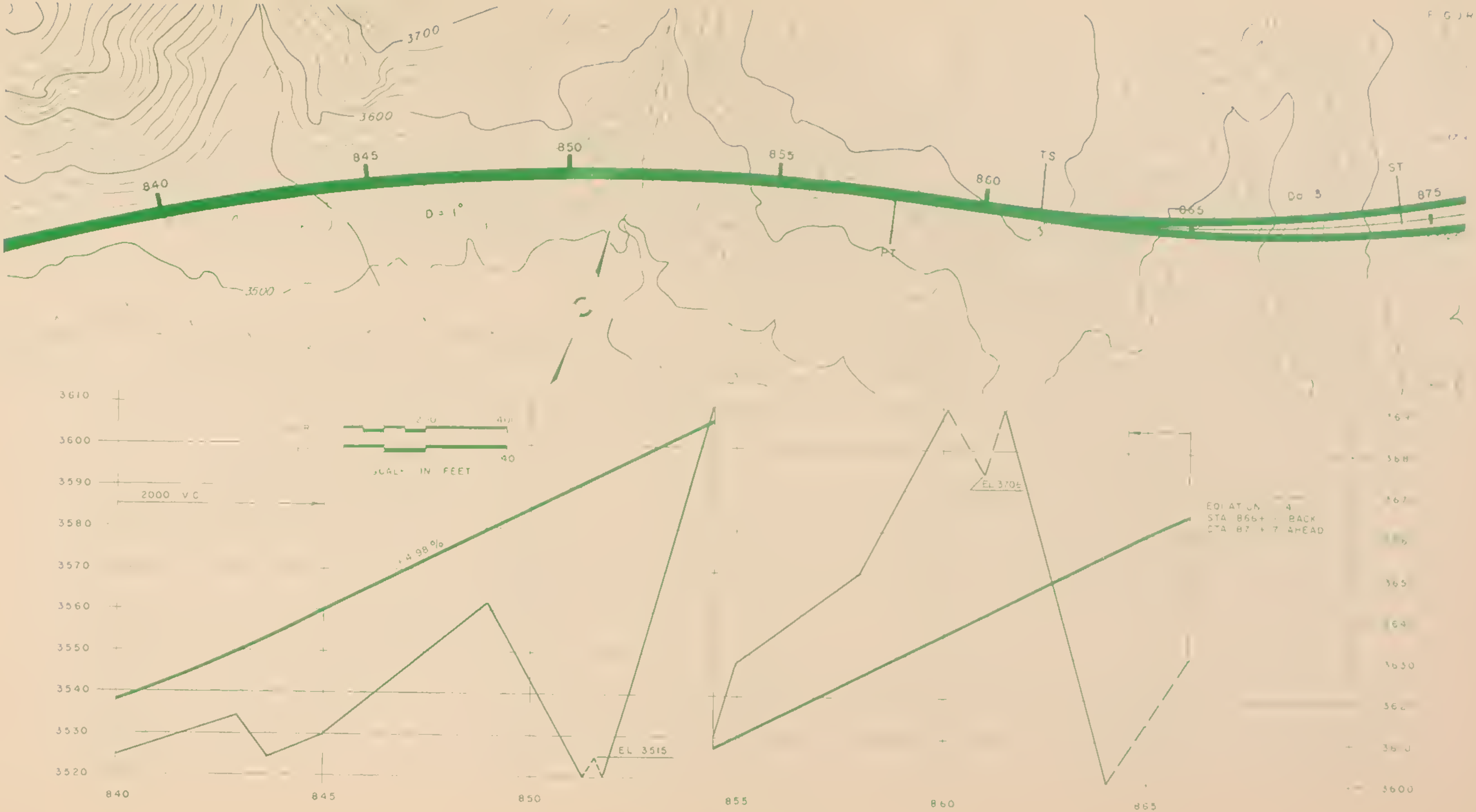
PLAN - PROFILE

FIGURE 12



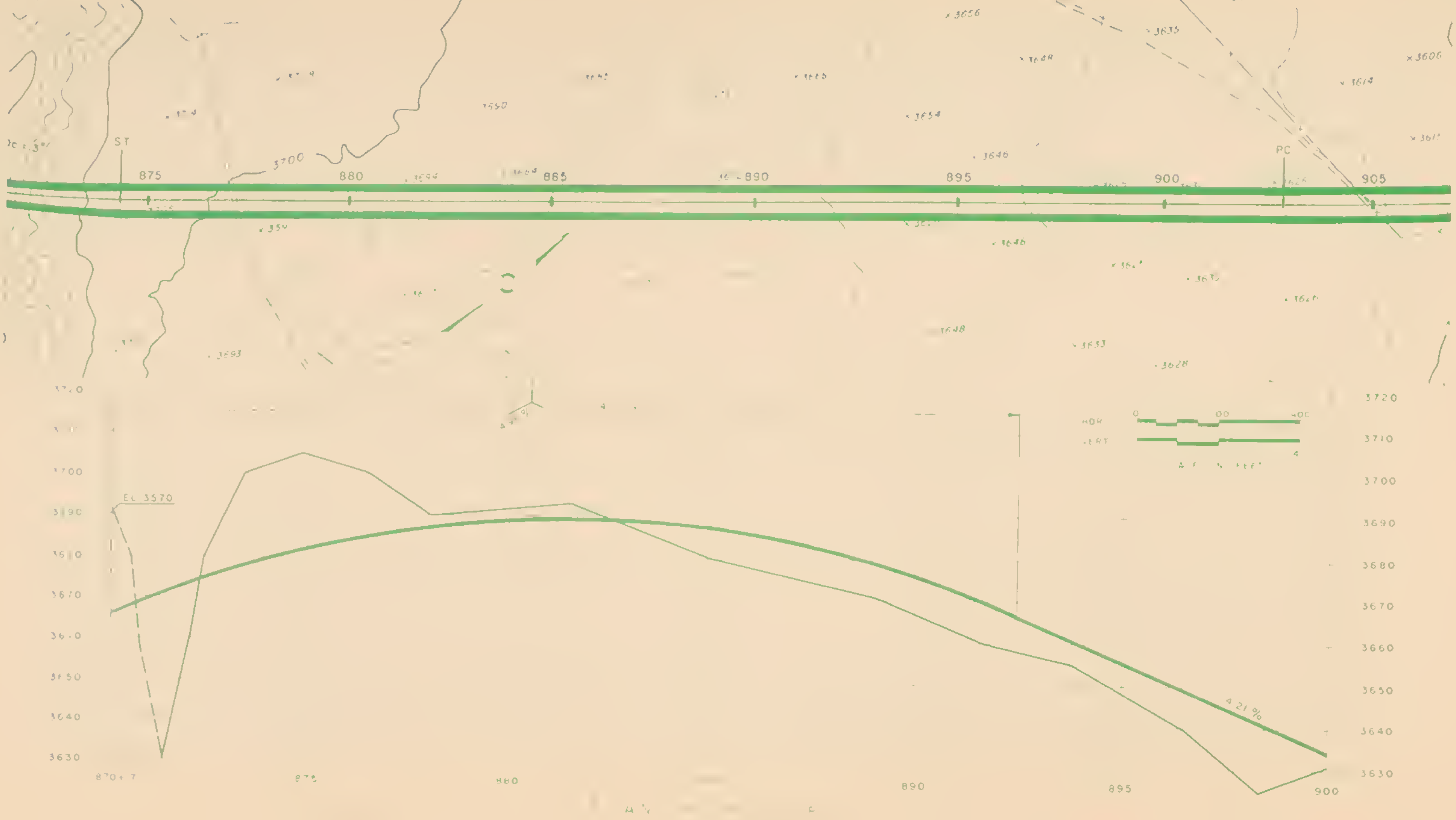
PLAN PROFILE

FIGURE 13

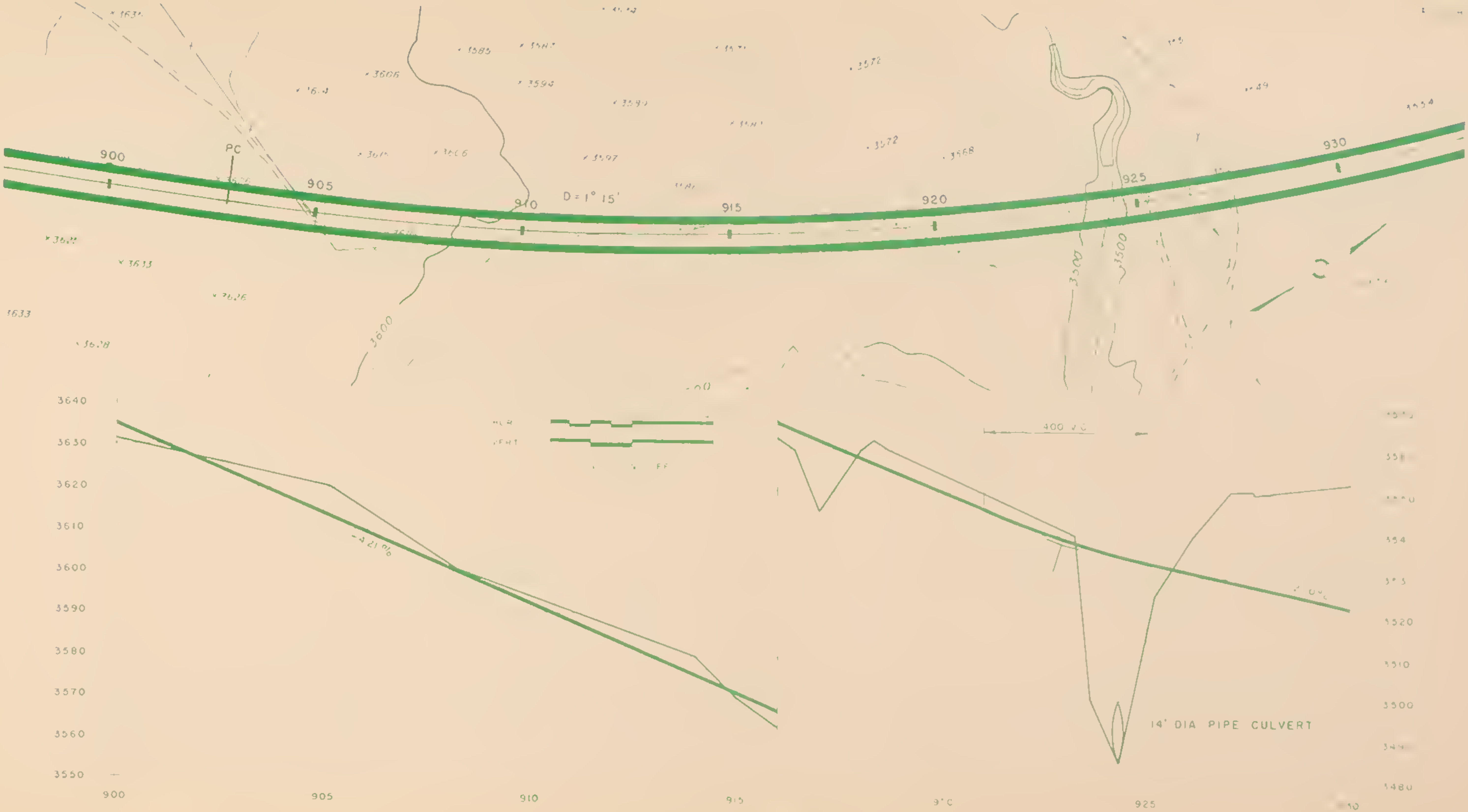


PLAN – PROFILE

FIGURE 14



ST
PC
3700
875
880
885
890
895
900
905
× 3656
× 3635
× 3648
× 3660
× 3654
3650
× 3646
× 3606
× 3614
× 3646
× 3648
× 3633
× 3628
× 3593
3720
3710
3700
3690
3680
3670
3660
3650
3640
3630
EL 3570
4.21 %
HOR
VERT
0
200
400
FEET
870+
875
880
890
895
900



PLAN AND PROFILE

FIGURE 16

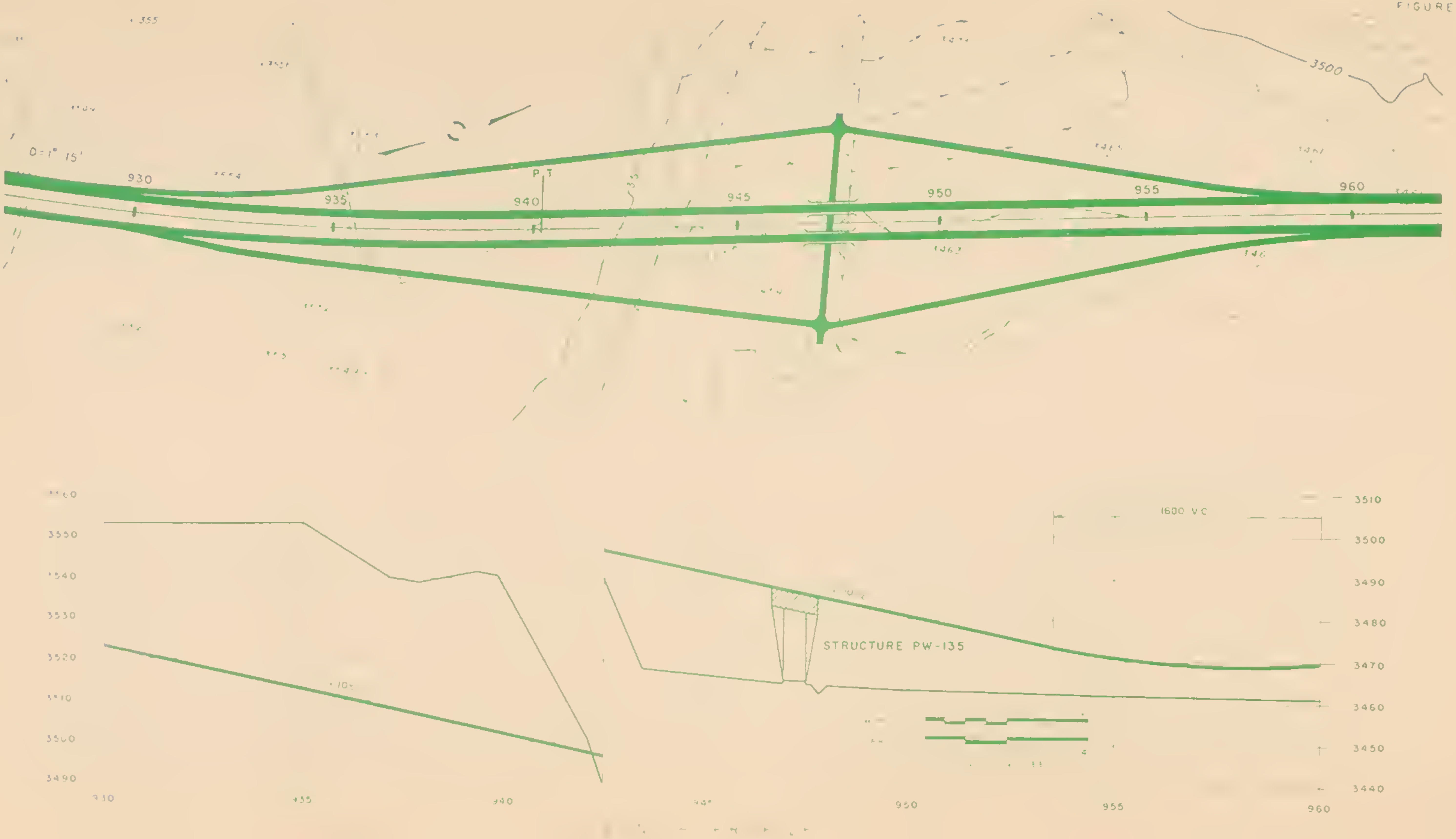
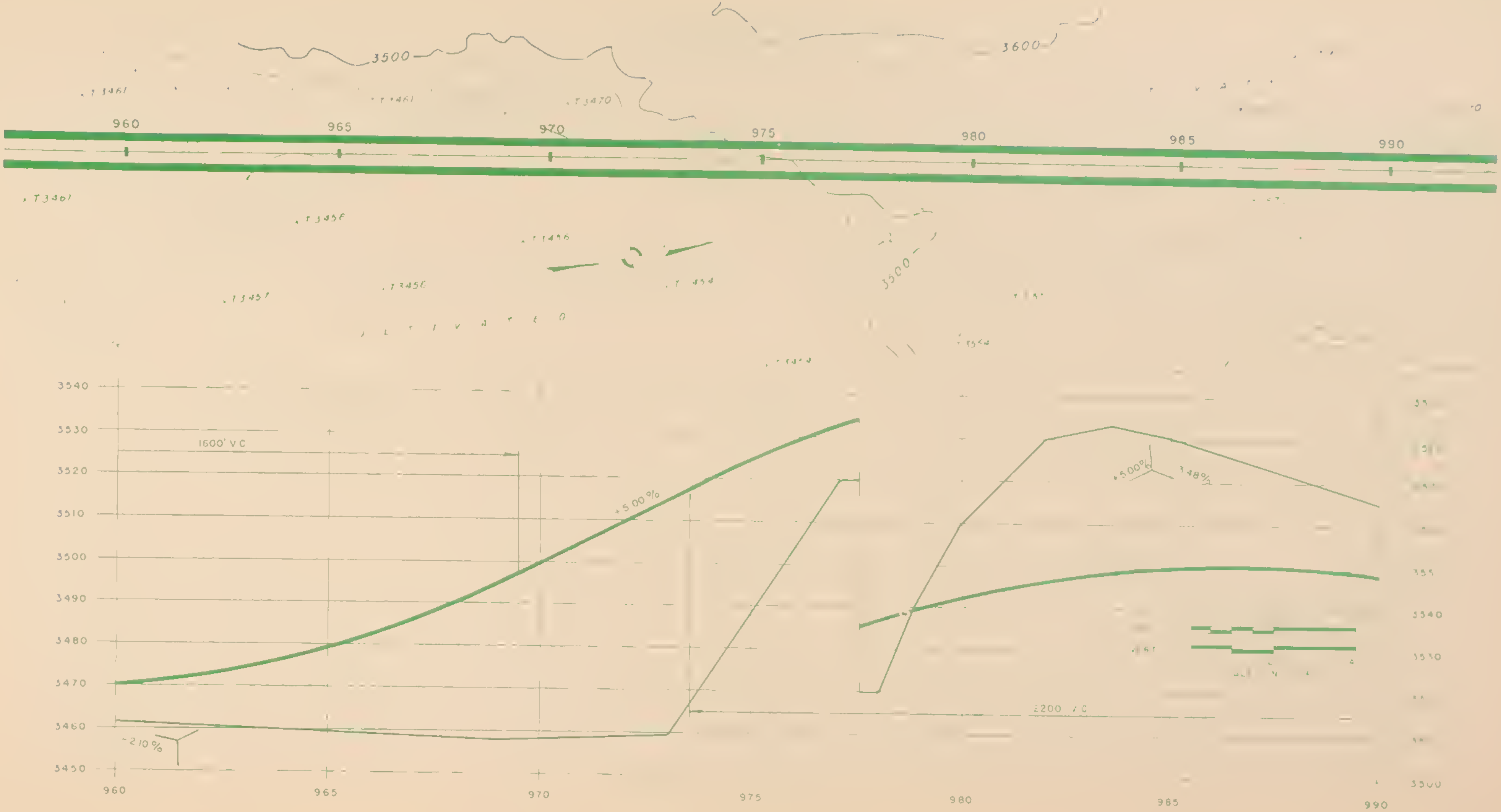
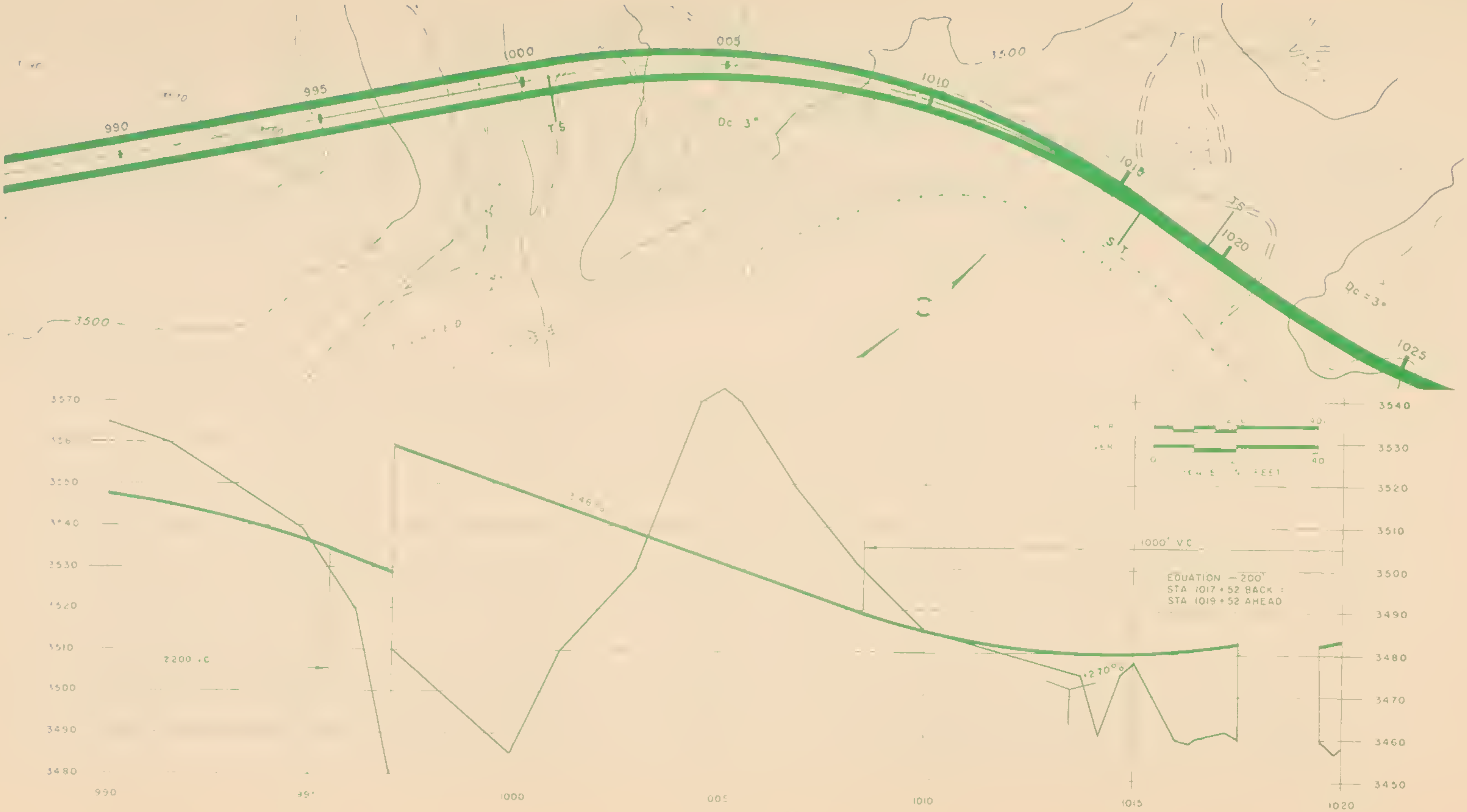

D=1° 15'
P.T.
1600 V.C.
STRUCTURE PW-135

FIGURE 17

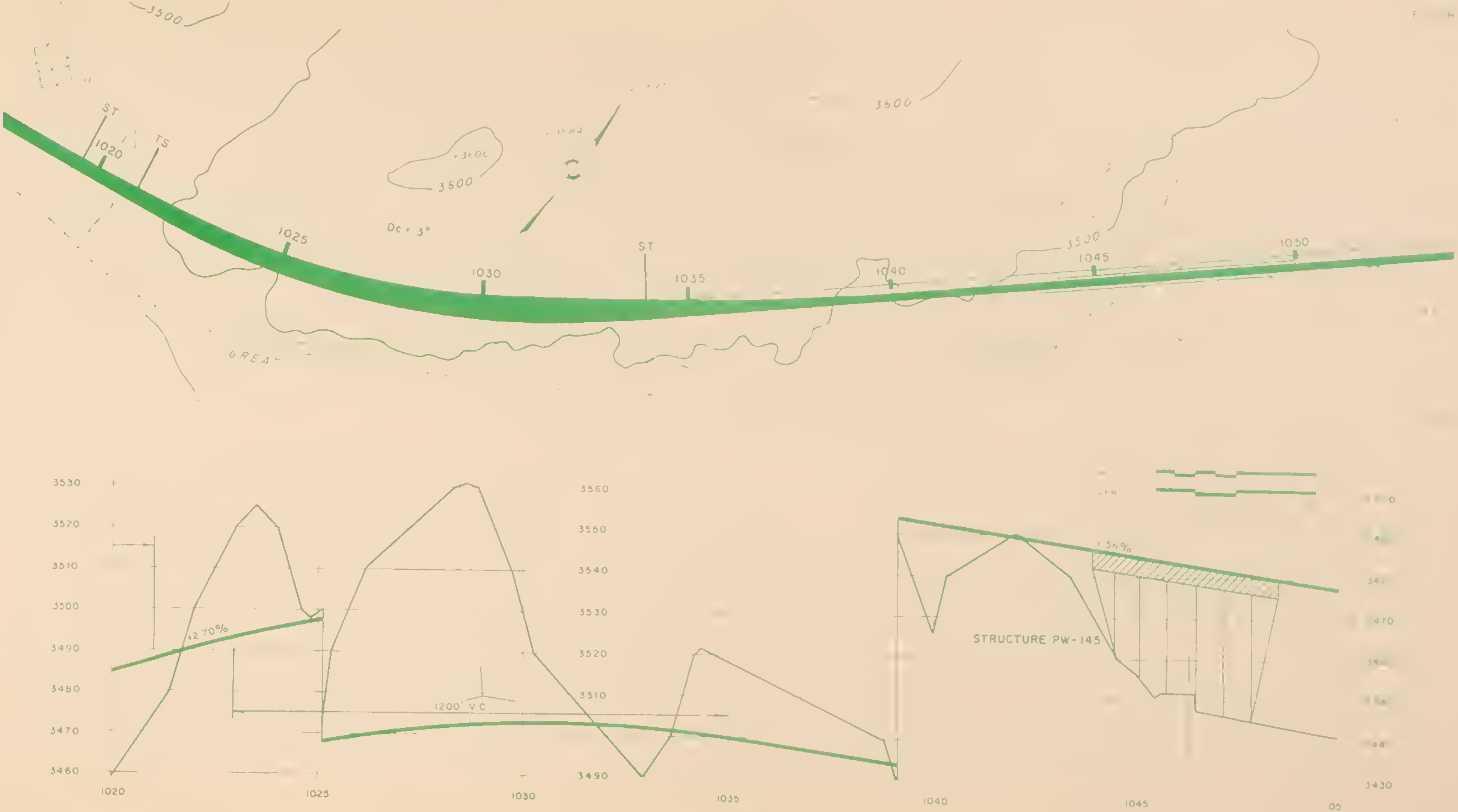


PLAN — PROFILE



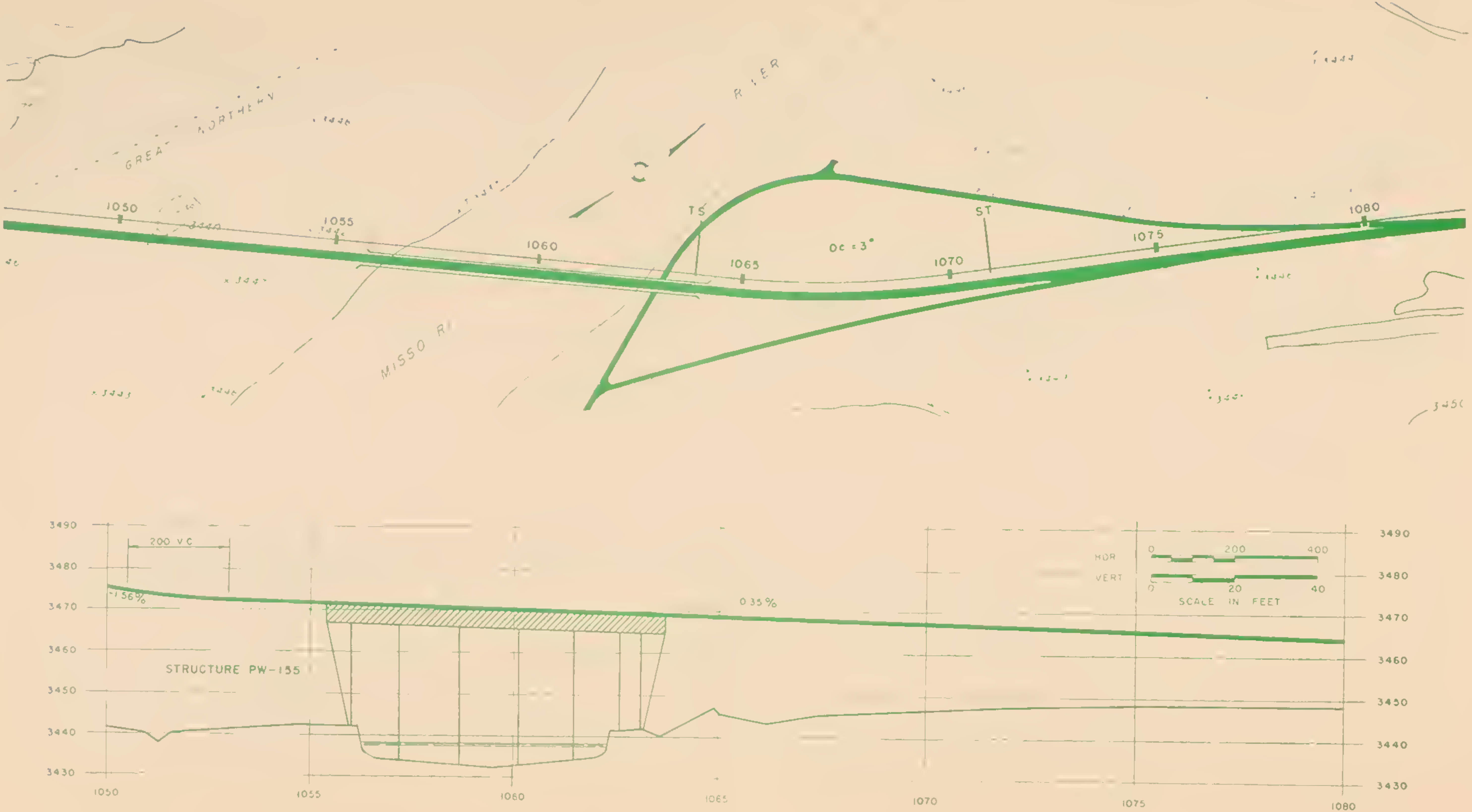
PLAN — PROFILE

FIGURE 9



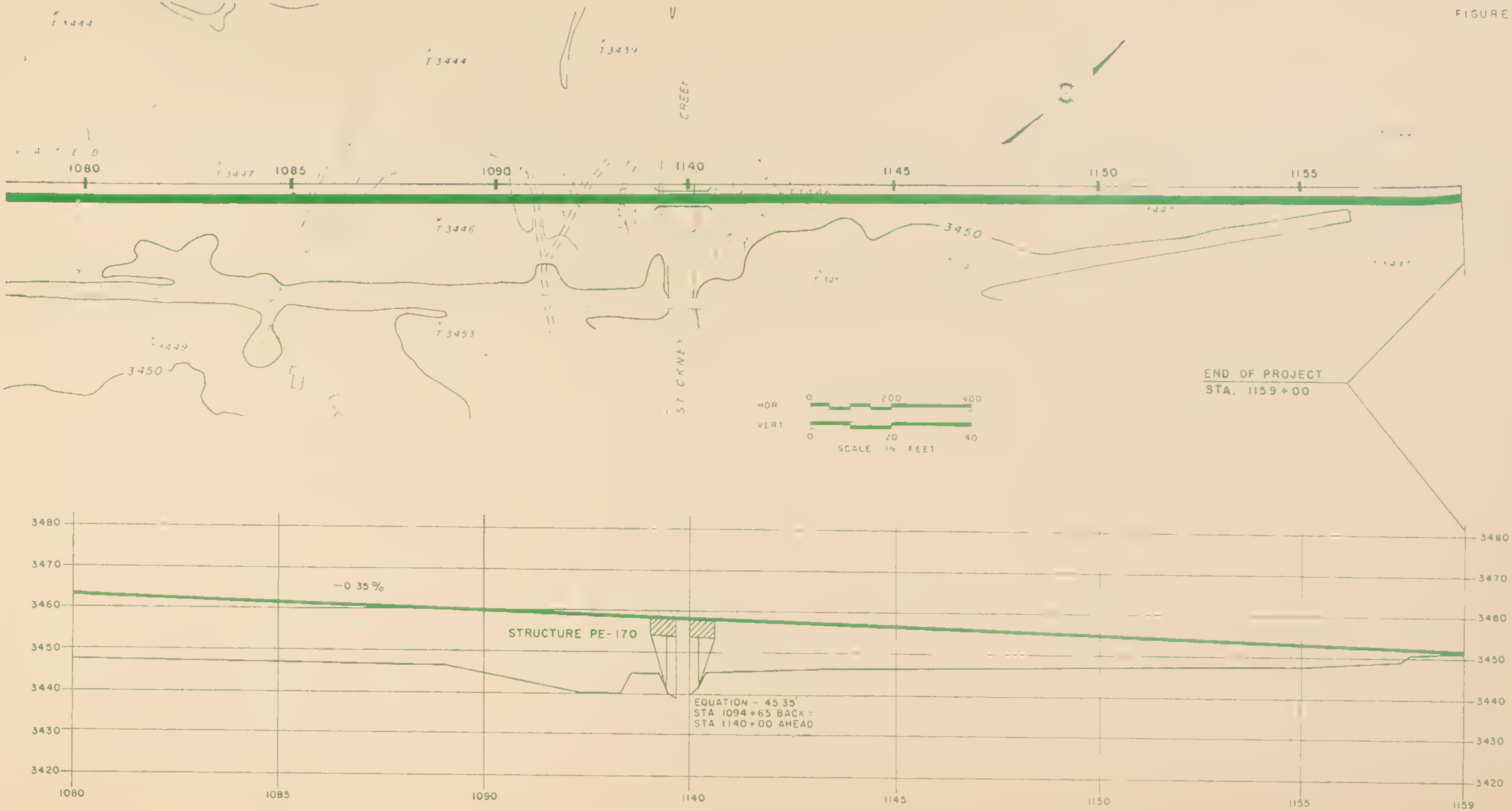
PLAN — PROFILE

FIGURE 20



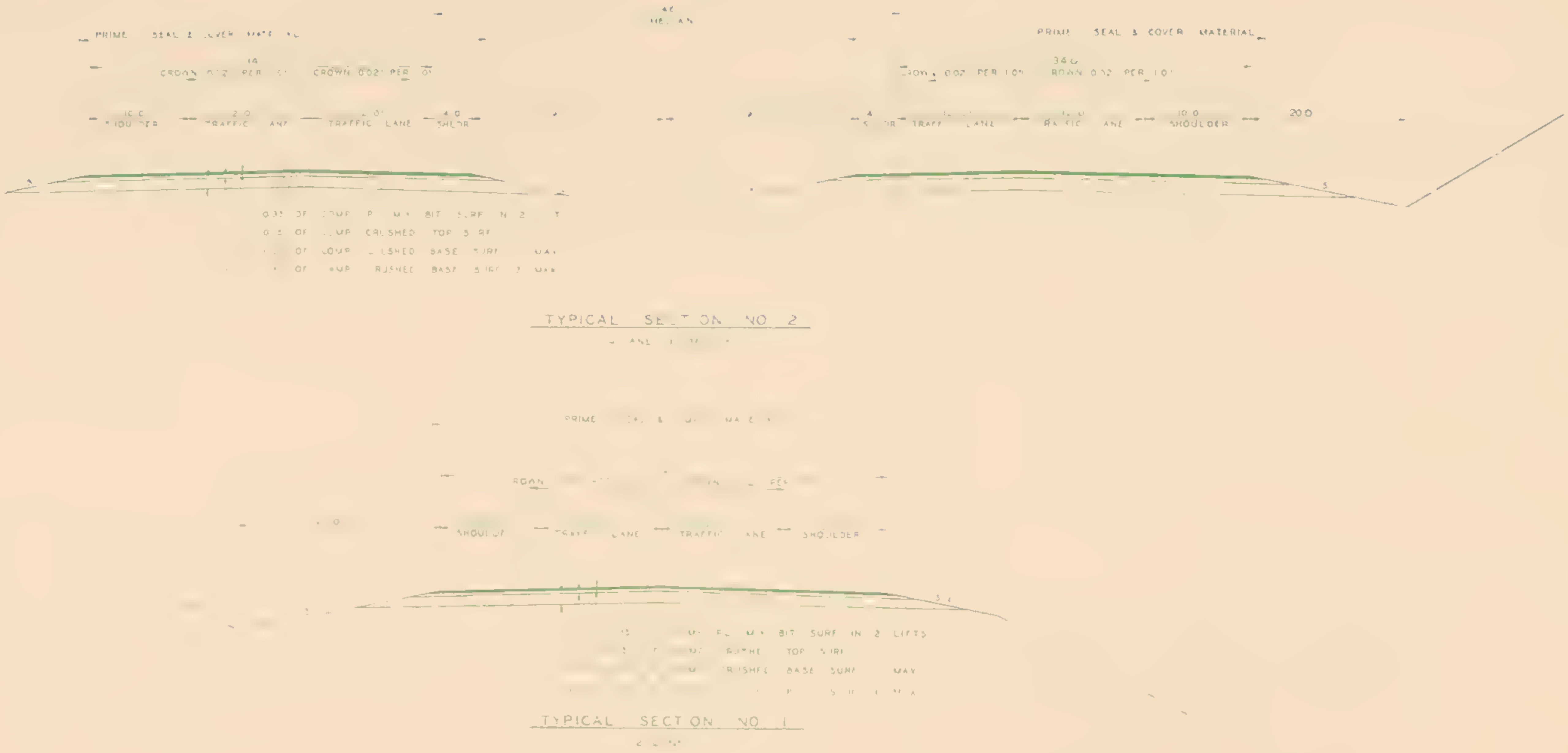
PLAN — PROFILE

FIGURE 21



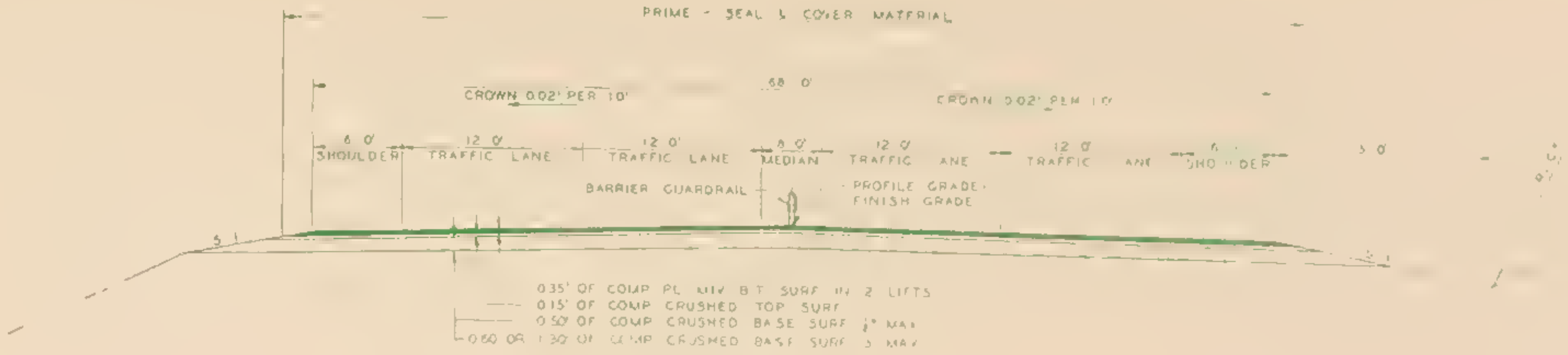
PLAN — PROFILE

FIGURE 22



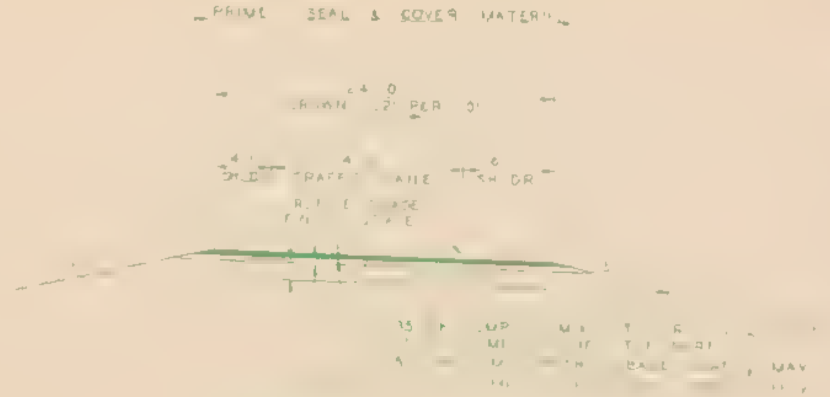
TYPICAL ROADWAY SECTIONS
INTERSTATE 15 - WOLF CREEK TO STICKNEY CREEK

FIGURE 23

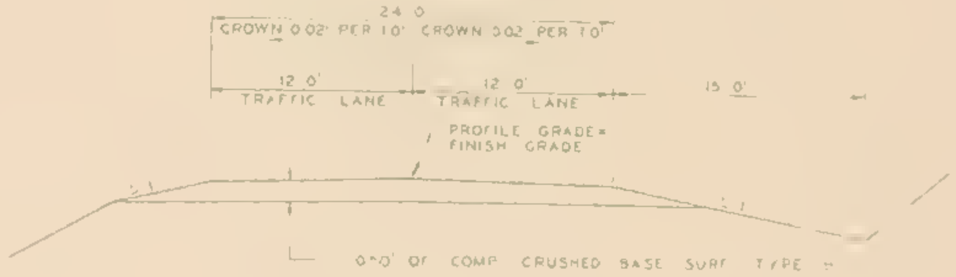

PRIME - SEAL & COVER MATERIAL
68 0'
CROWN 0.02' PER 10'
CROWN 0.02' PER 10'
6 0' SHOULDER
12 0' TRAFFIC LANE
12 0' TRAFFIC LANE
8 0' MEDIAN
12 0' TRAFFIC LANE
12 0' TRAFFIC LANE
6 SHOULDER
5 0'
BARRIER GUARDRAIL
PROFILE GRADE = FINISH GRADE
0.35' OF COMP PL MIX B T SURF IN 2 LIFTS
0.15' OF COMP CRUSHED TOP SURF
0.50' OF COMP CRUSHED BASE SURF 1" MAX
0.60 OR 1.30' OF COMP CRUSHED BASE SURF 3 MAX

TYPICAL SECTION NO 3

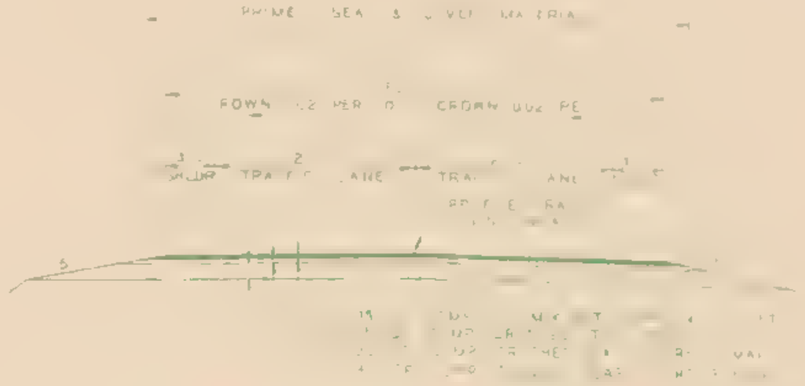
4 LANE NARROW MEDIAN



INTERSTATE RAMPS



FRONTAGE ROADS



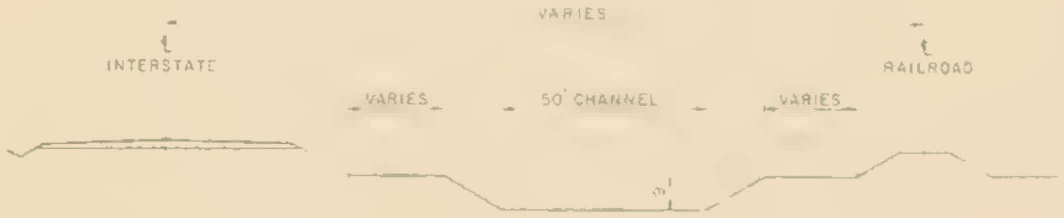
PRIMARY CONNECTION TO AUGUSTA HIGHWAY F.A.P. 238

GENERAL NOTES

1 BACKSLOPES

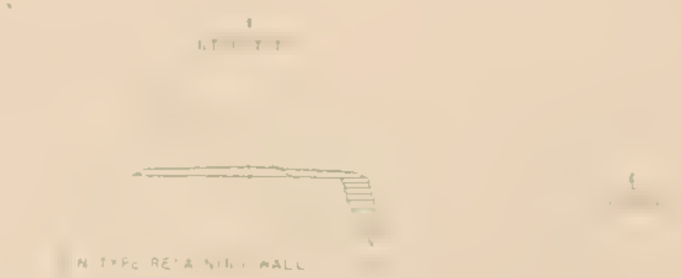
CUT OR FILL DEPTH	0-5	5-10	OVER 10	ROCK
CUT SLOPE	5	3	2	½:1
FILL SLOPE	5:1	2½	2:1	1½:1

2 CUT BACKSLOPE ROUNDING
USE 5×5 IN CUTS UP TO 15 FEET
USE 8×8 IN CUTS OVER 15 FEET
NO ROUNDING IN SOLID ROCK CUTS

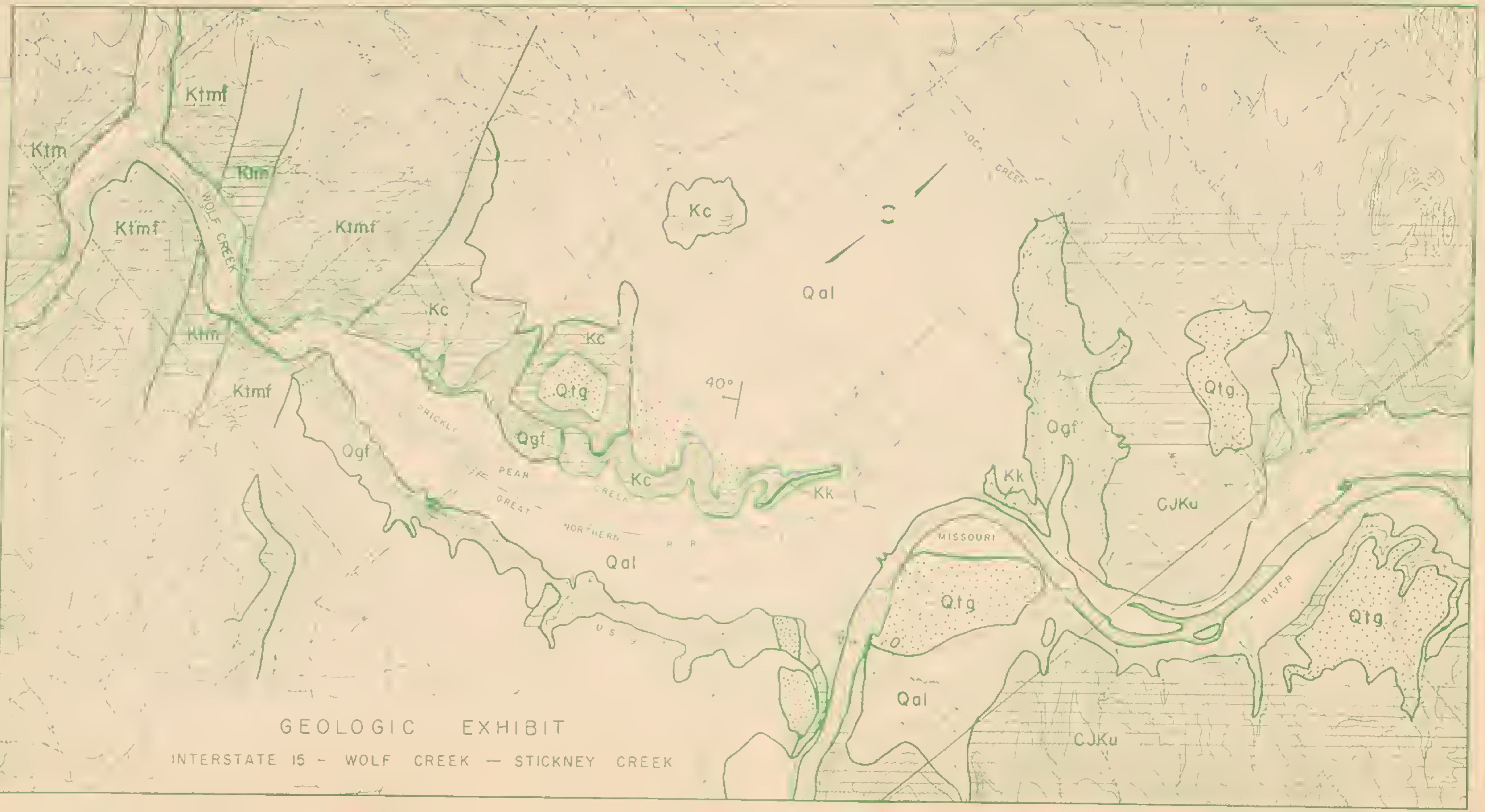


TYPICAL CHANNEL CHANGE - LITTLE PRICKLY PEAR CREEK

TYPICAL ROADWAY SECTIONS
INTERSTATE 15 - WOLF CREEK TO STICKNEY CREEK



ROADWAY SECTION USING BIN TYPE RETAINING WALL



GEOLOGIC EXHIBIT

INTERSTATE 15 - WOLF CREEK — STICKNEY CREEK

FIGURE 25

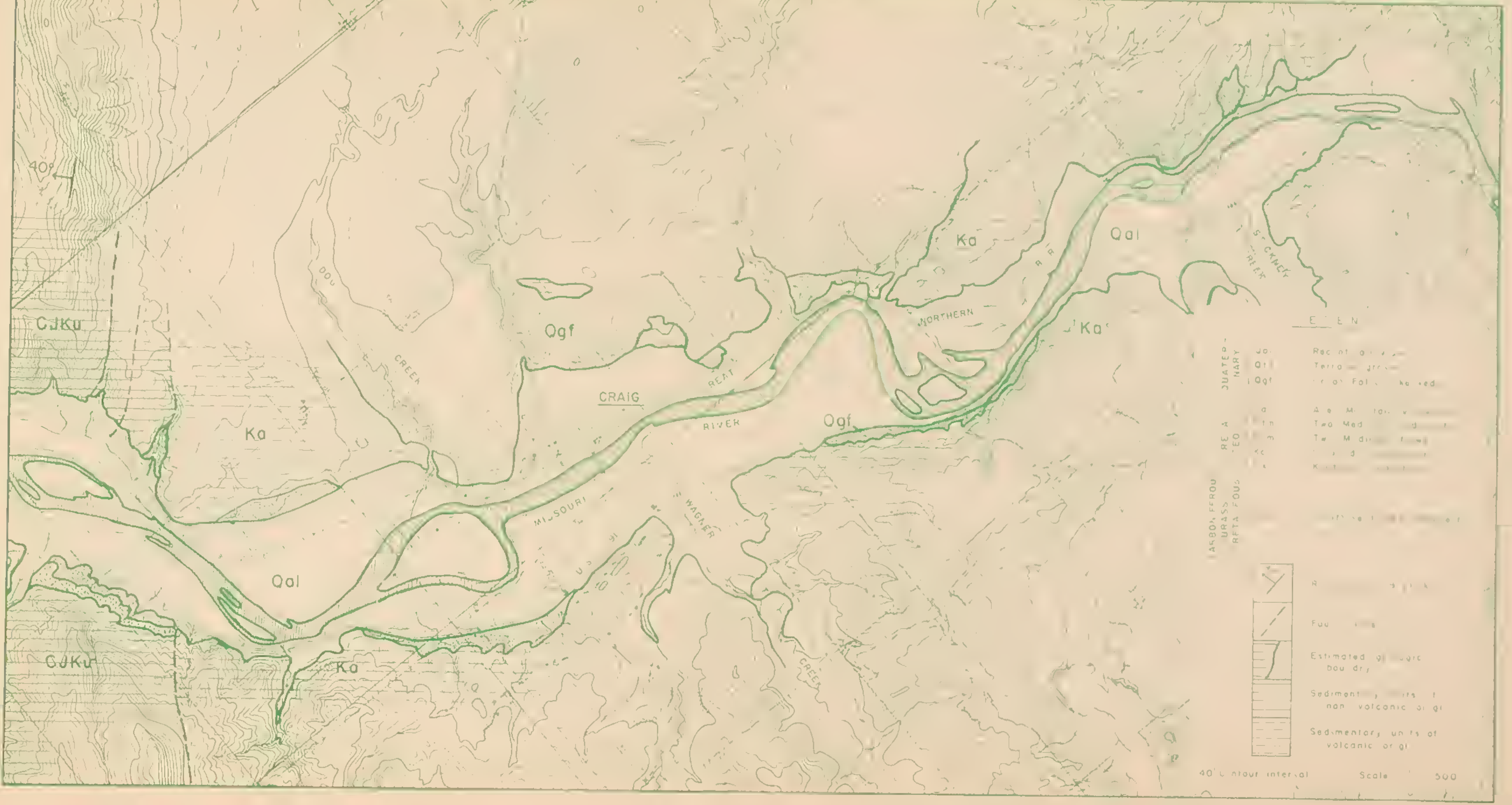
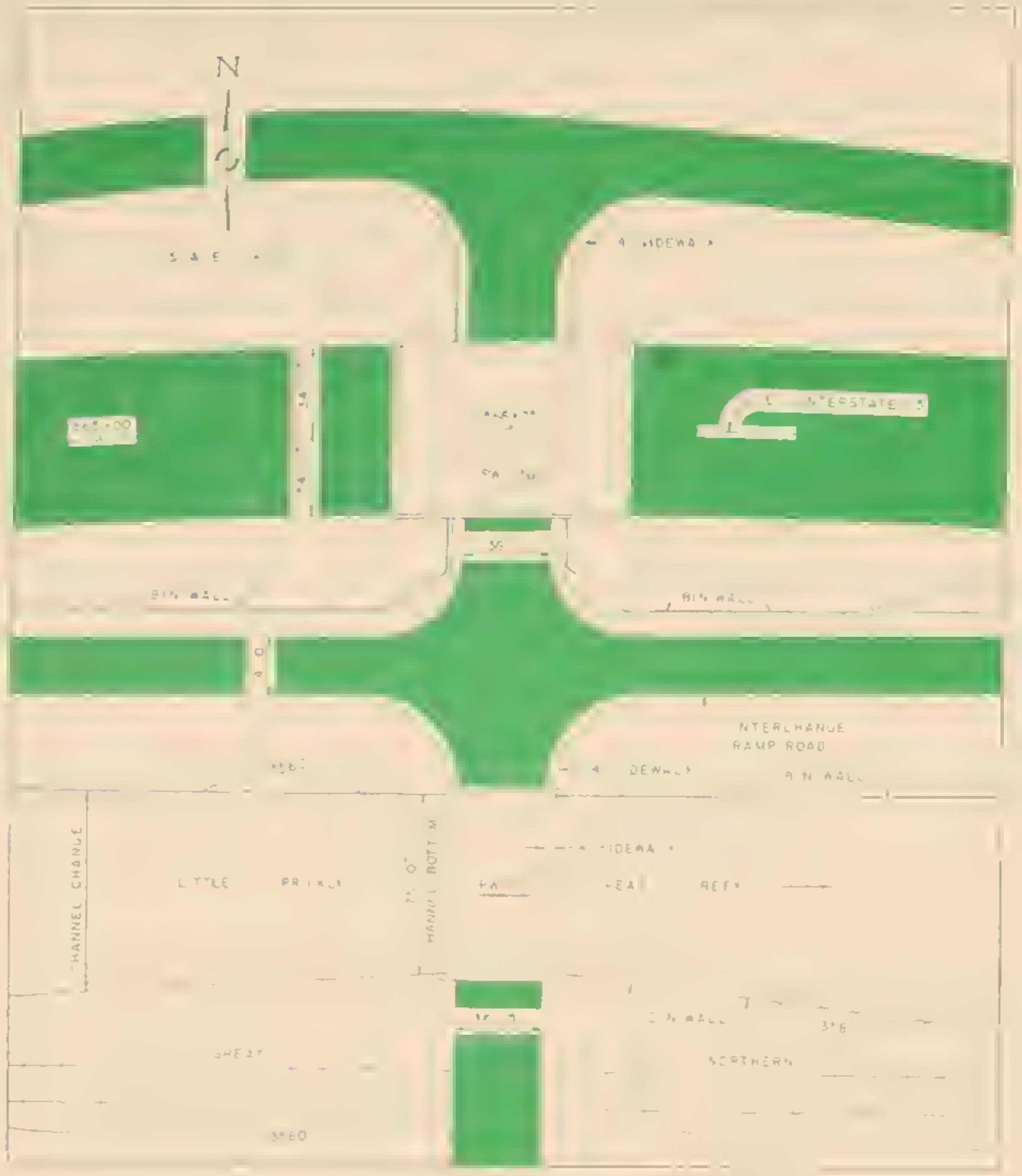
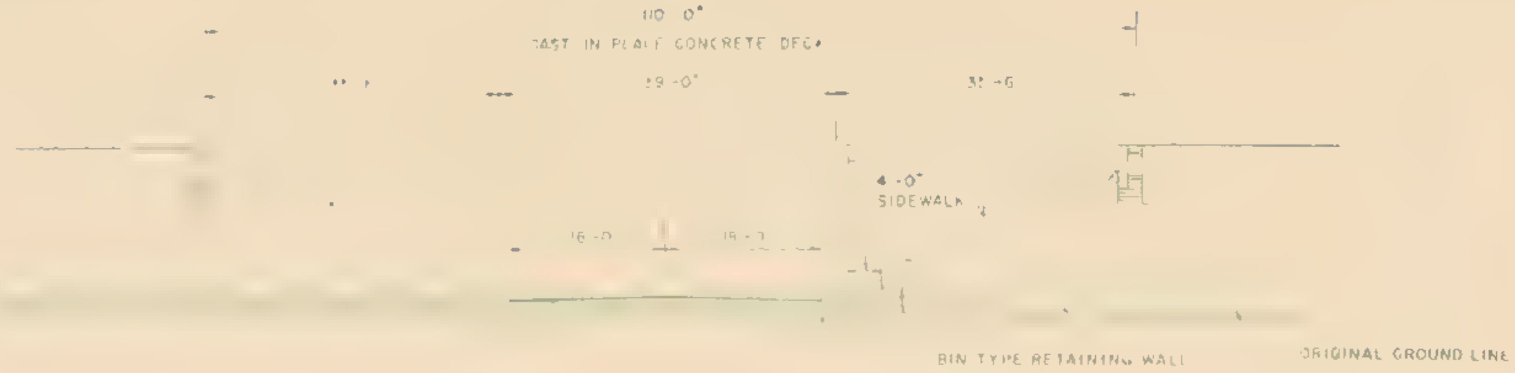

CRAIG
MISSOURI RIVER
GREAT NORTHERN R R
DOG CREEK
WAGNER CREEK
STICKNEY CREEK
U S 91
CJKu
Ka
Qgf
Qal
40°
LEGEND
QUATERNARY
Qal
Qtl
Qgf
Recent alluvium
Terrace gravel
Glacial Fort Lake sediments
Ka
Two Medicine
Two Medicine
Kootenai
CARBONIFEROUS
JURASSIC
CRETACEOUS
Fault
Estimated geologic boundary
Sedimentary units of non volcanic origin
Sedimentary units of volcanic origin
40' contour interval
Scale
500

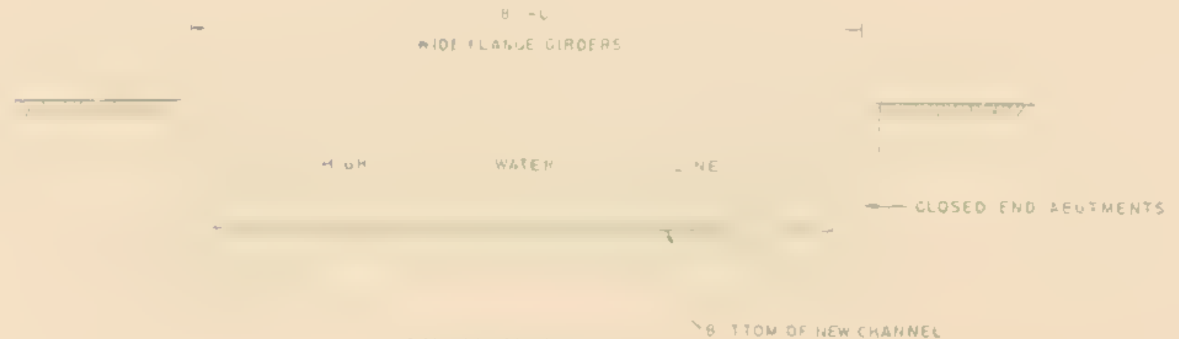
FIGURE 26



PLAN VIEW



STRUCTURE PW-30
SCALE 1"=20



STRUCTURE PW-40
SCALE-1"=

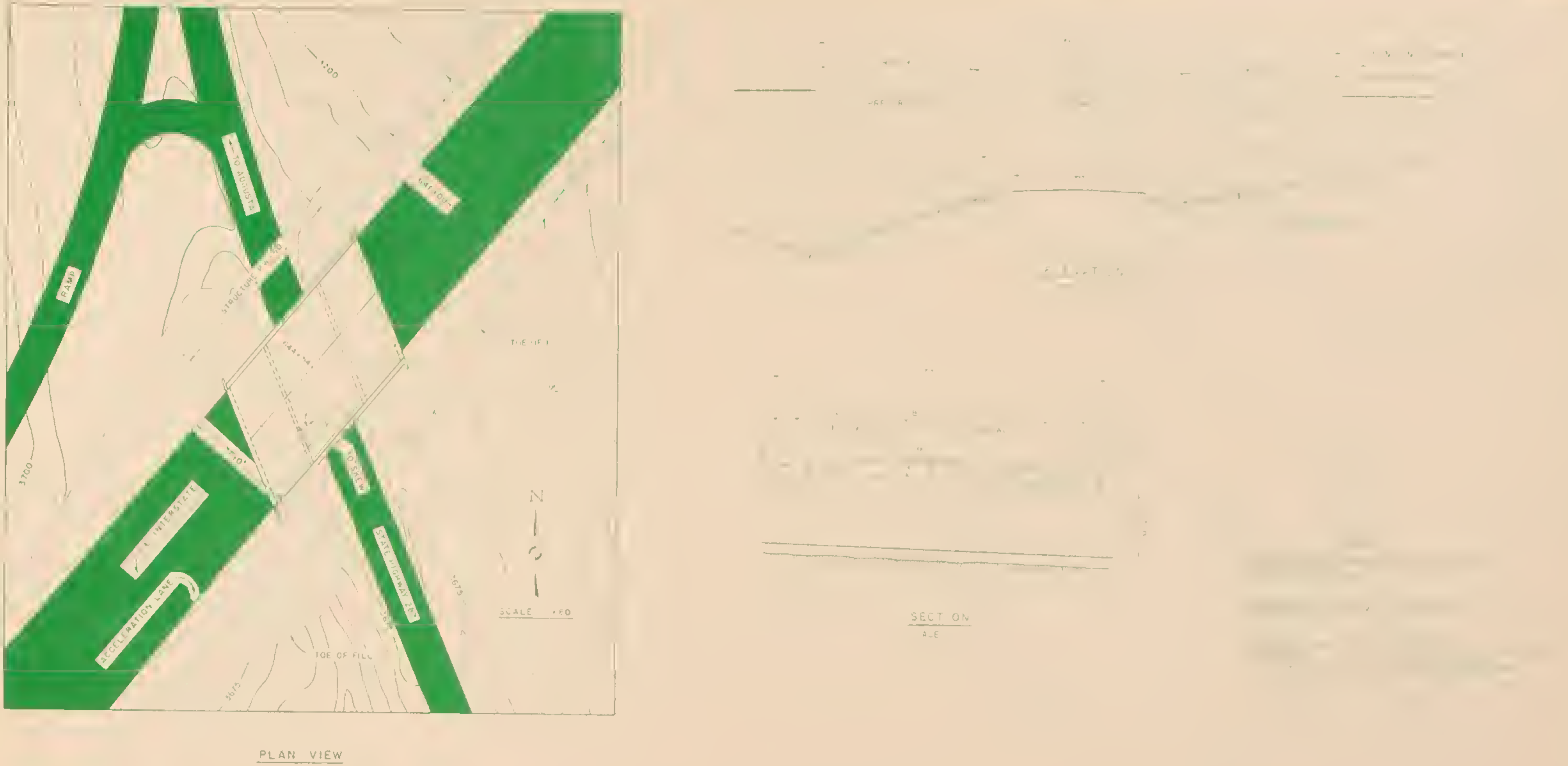
STRUCTURE PW-30
1 DESIGN LOADING H20 S16 OR ALTERNATE MILITARY LOADING
2 COST AREA 7,948 SQ FT (STRUCTURE)
3 BIN WALL QUANTITIES INCLUDED IN GRADING WORK

STRUCTURE PW-40
DESIGN LOADING H15 S12
2 COST AREA 3,600 SQ FT (STRUCTURE)
3 WATERWAY AREA A WATERWAY AREA OF 525 SQ FT HAS BEEN PROVIDED FOR A FLOW OF 3,800 cfs
4 CHANNEL CHANGE QUANTITIES INCLUDED IN GRADING WORK

STRUCTURES PW-30 & PW-40

[illegible]

FIGURE 27



PLAN VIEW

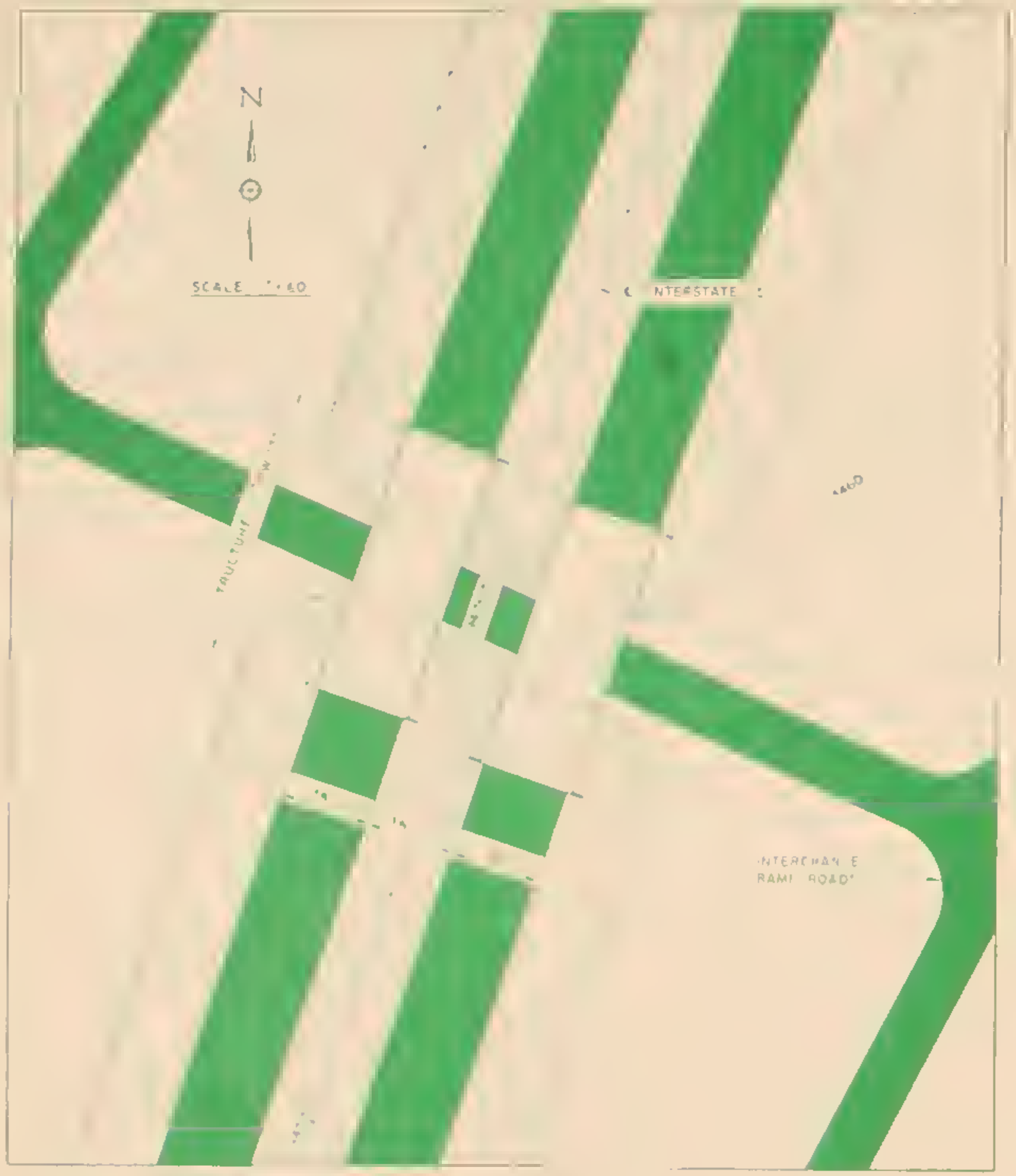
ELEVATION

SECTION

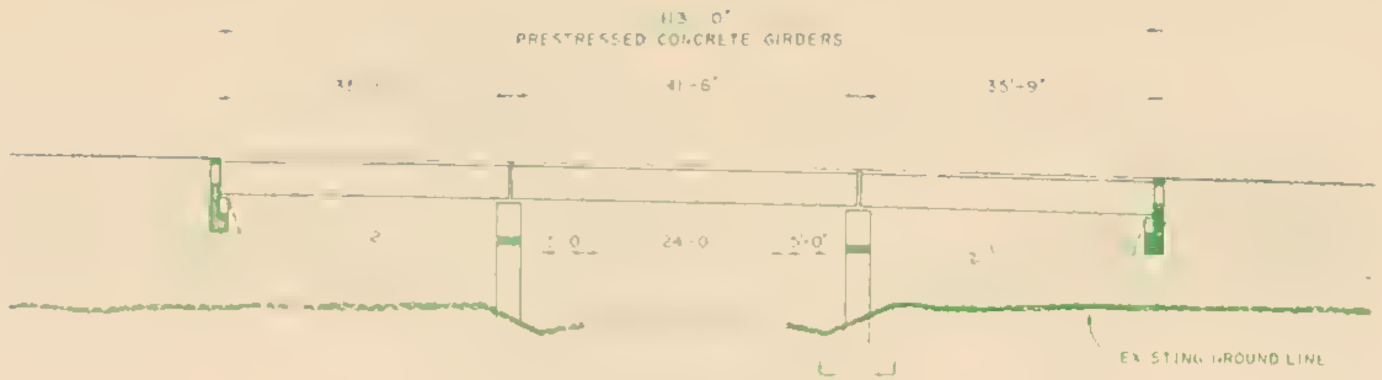
STRUCTURE PW-60

INTERSTATE 5 - WOLF [illegible] KNEY REE[illegible]

FIGURE 28

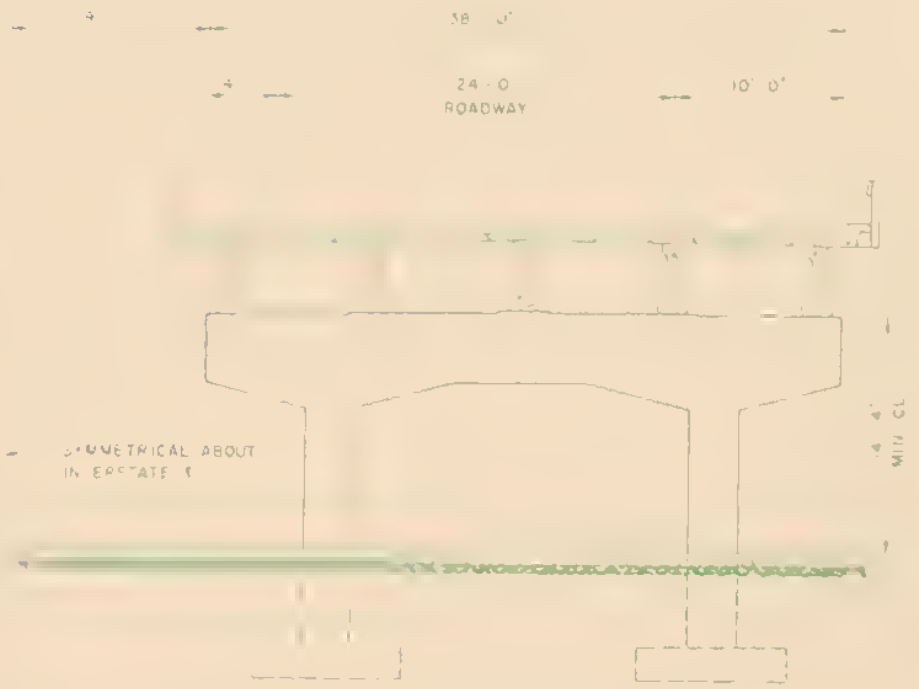


PLAN VIEW



ELEVATION

SCALE 1" = 20'



SECTION

SCALE 1" = 10

NOTES

1 DESIGN LOADING H20-S16 OR ALTERNATE MILITARY LOADING

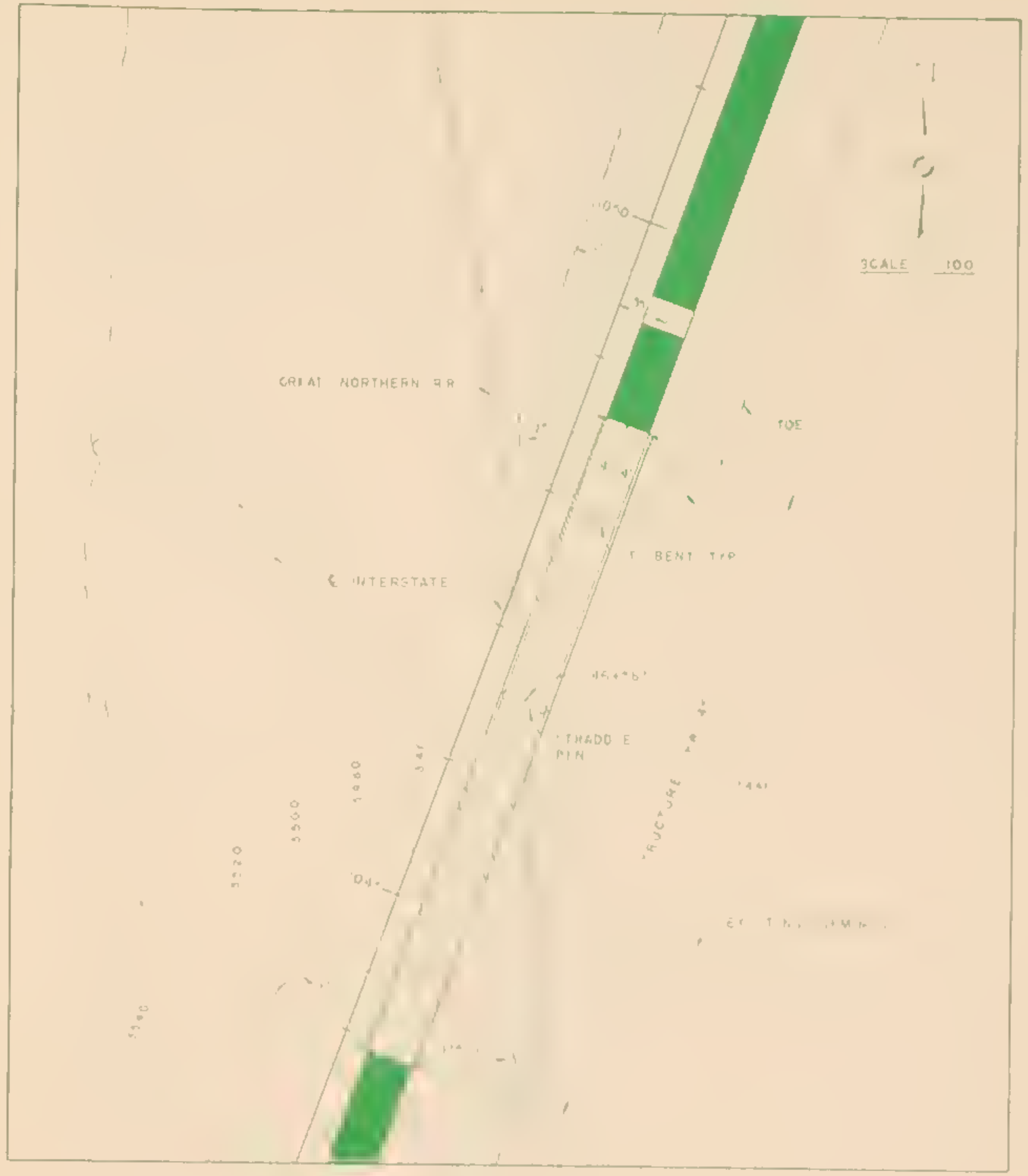
2 COST AREA 9,549 SQ FT (STRUCTURE)

3 DRAINAGE PROVIDE DRAINAGE INLETS AND DRAINS AS REQUIRED FOR ROAD UNDER THE STRUCTURE

STRUCTURE PW-135

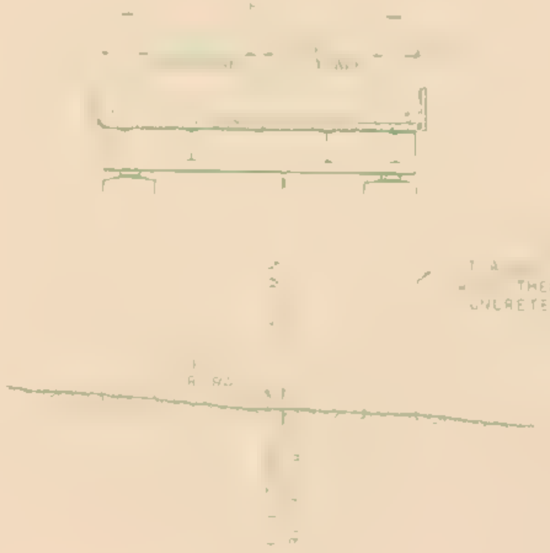
INTERSTATE 15 - WOLF CREEK TO STICKNEY CREEK

FIGURE 29



PLAN VIEW

ELEVATION

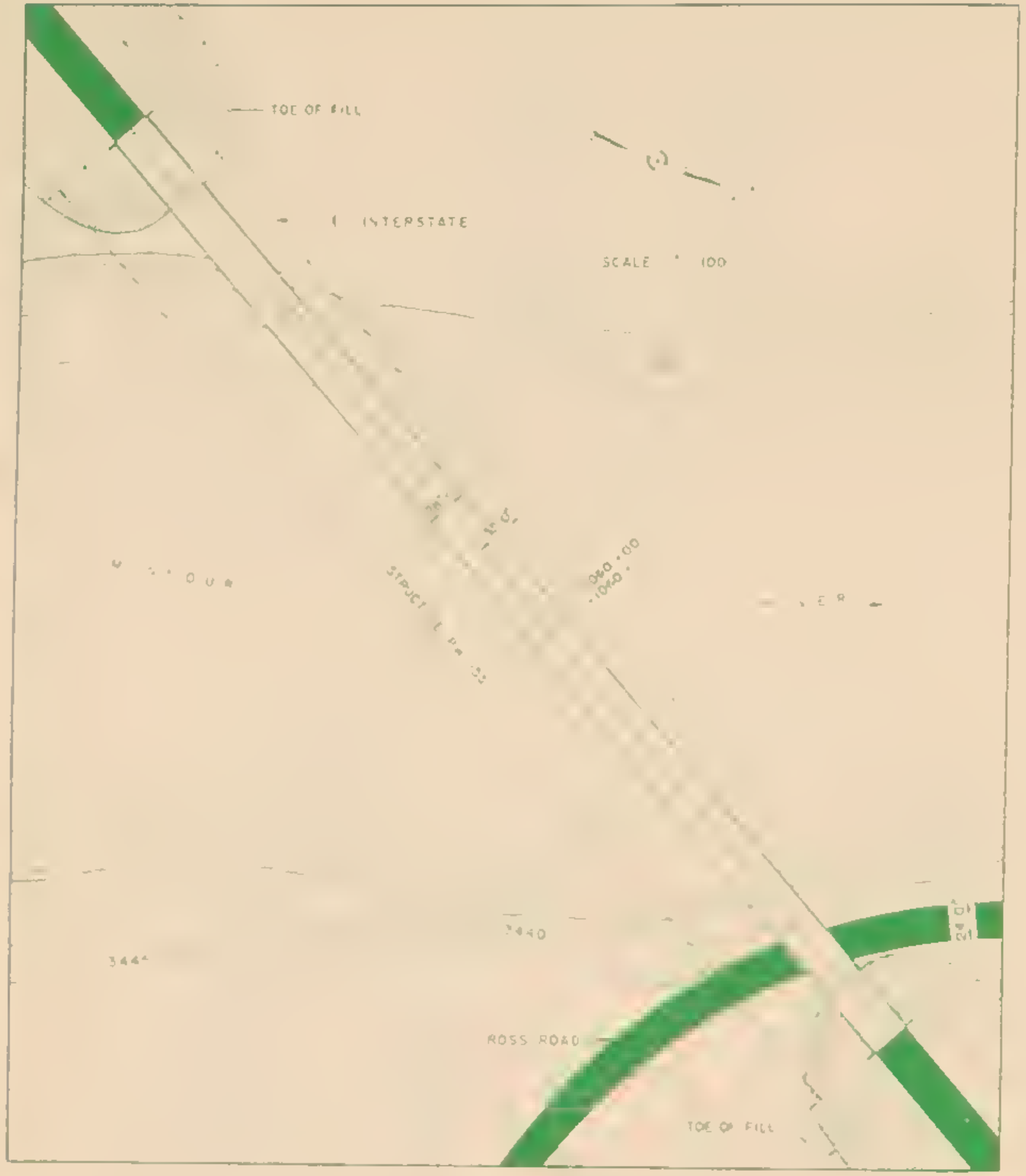


SECTION

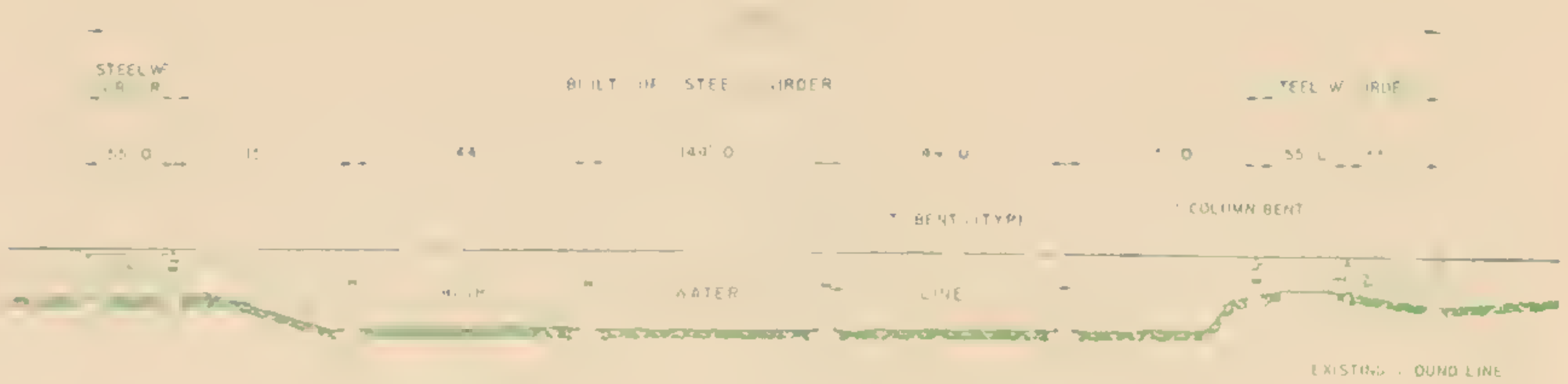
MINIMUM RAILROAD CLEARANCE

STRUCTURE PW-145

FIGURE 30



PLAN VIEW



ELEVATION

SCALE 1" = 100'

INTERSTATE

NOTES

DESIGN LOADING H20 S16 OR ALTERNATE MILITARY LOADING

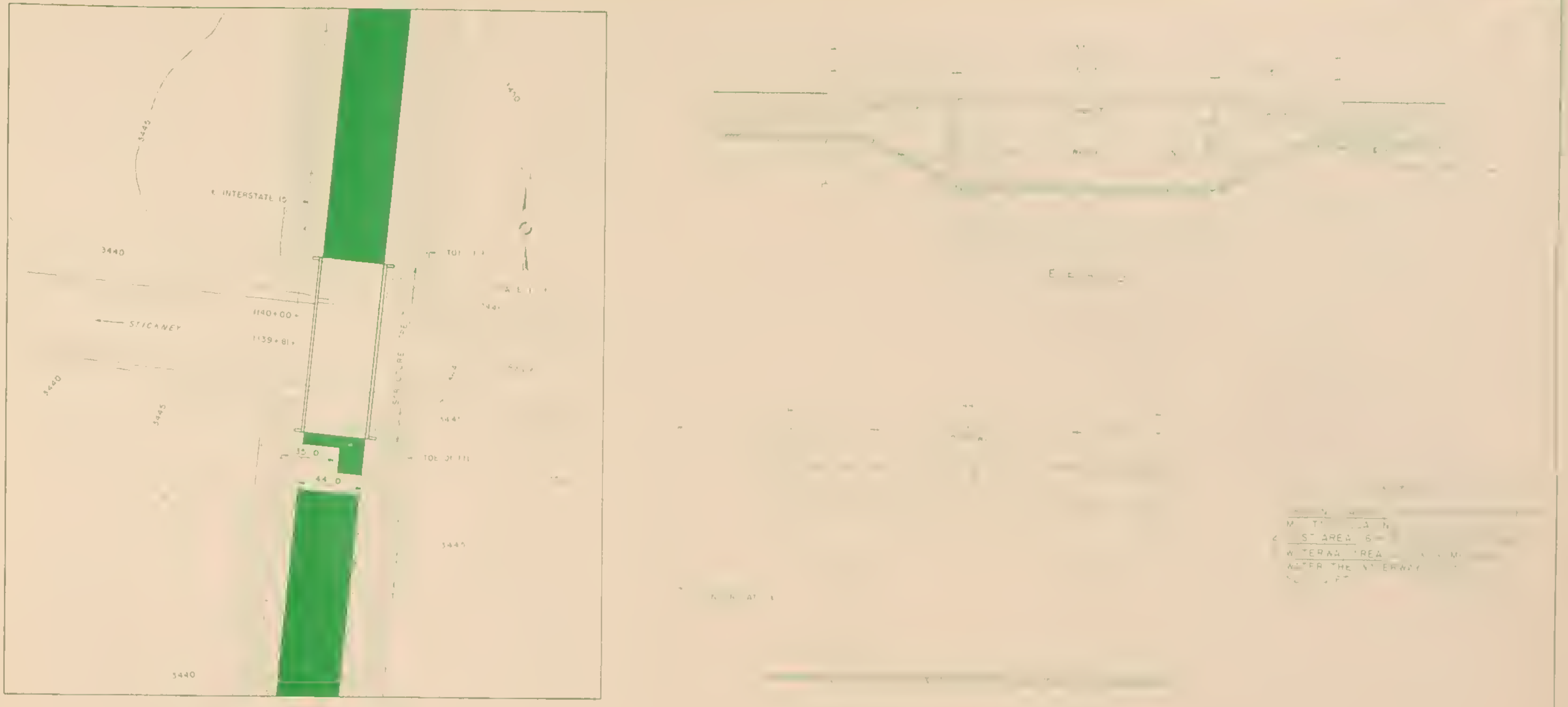
2 COST AREA 26,671 SQ FT STRUCTURE

SECTION

SCALE 1" = 10'

STRUCTURE PW-155

INTERSTATE 15 - WOLF CREEK TO STICKNEY CREEK



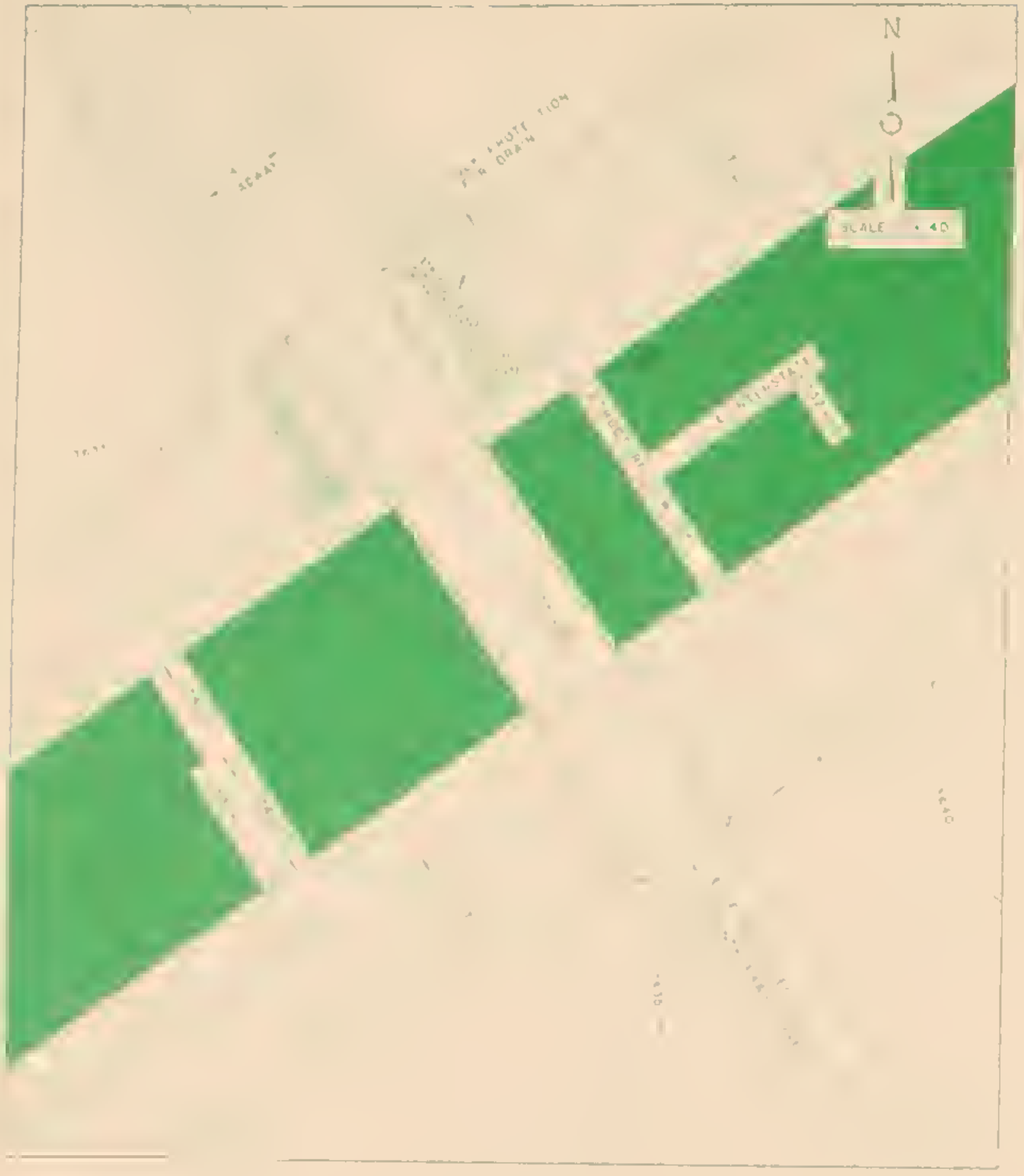
PLAN VIEW

SECTION

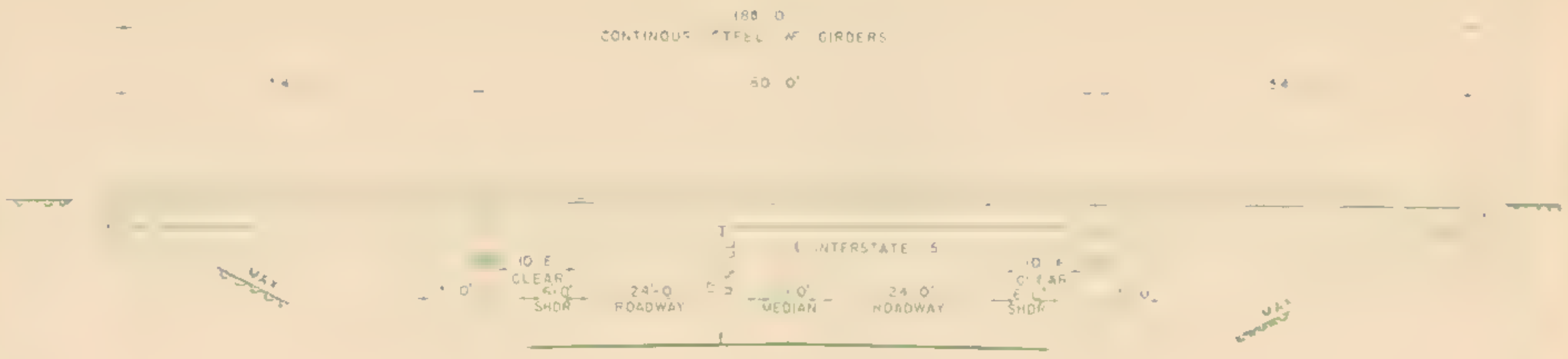
SCALE

STRUCTURE PE-170

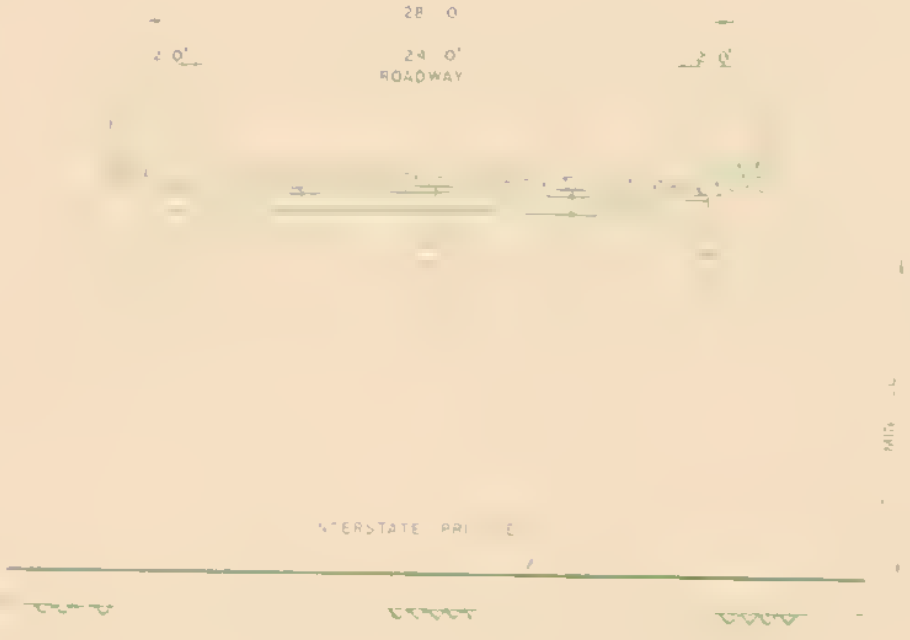
INTERSTATE 15 - WOLF CREEK TO STICKNEY CREEK



PLAN VIEW



ELEVATION



SECTION
SCALE ⅛" = 1' 0"

NOTES

1. DESIGN LOADING H15 S 2
2. COST AREA 6,063 SQ FT (STRUCTURE)
3. ROCK DRAIN TO BE INCLUDED IN GRADING CONTRACT

STRUCTURE PW-105

INTERSTATE 15 WOLF CREEK TO STICKNEY CREEK

DIVISION 3

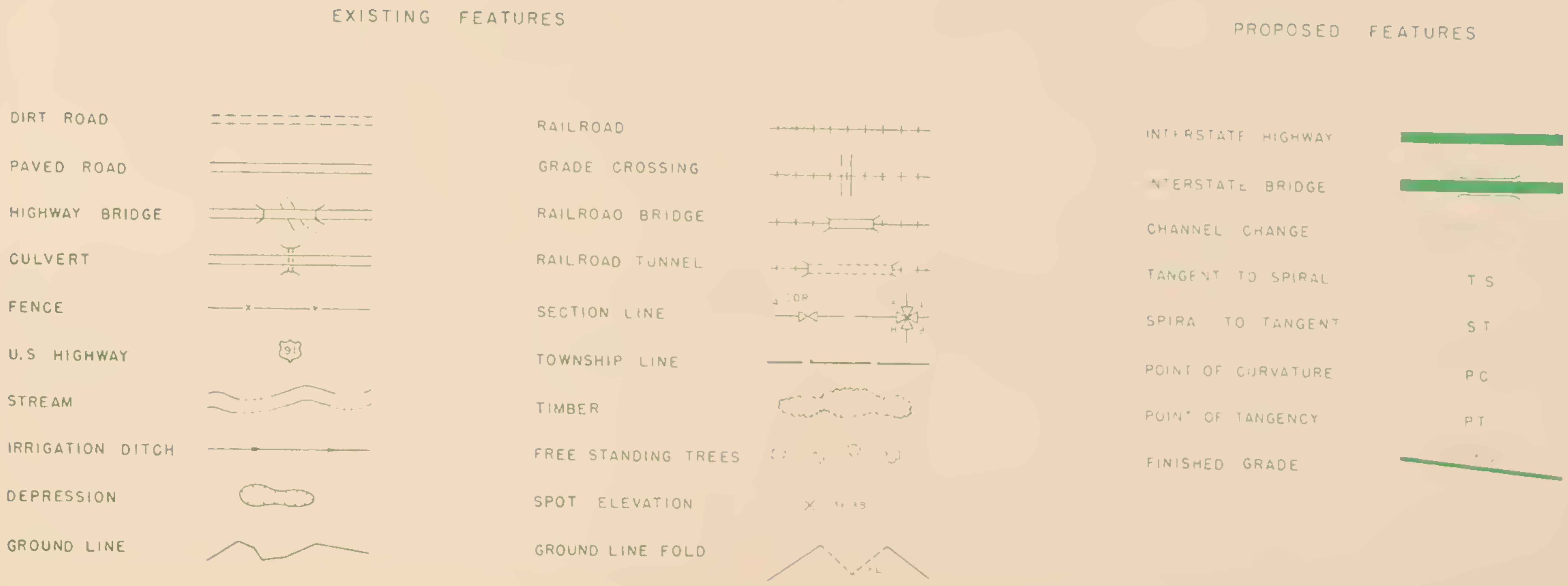
ALTERNATE LOCATIONS L, N, O, P, Q AND R
PLAN AND PROFILES

LOCATION L - FIGURE 102 TO 107
LOCATION N - FIGURE 107 TO 108
LOCATION O - FIGURE 108 TO 110
LOCATION P - FIGURE 110 TO 112
LOCATION Q - FIGURE 112 TO 114
LOCATION R - FIGURE 114 TO 115

LOCATIONS L, N, O, P, Q & R

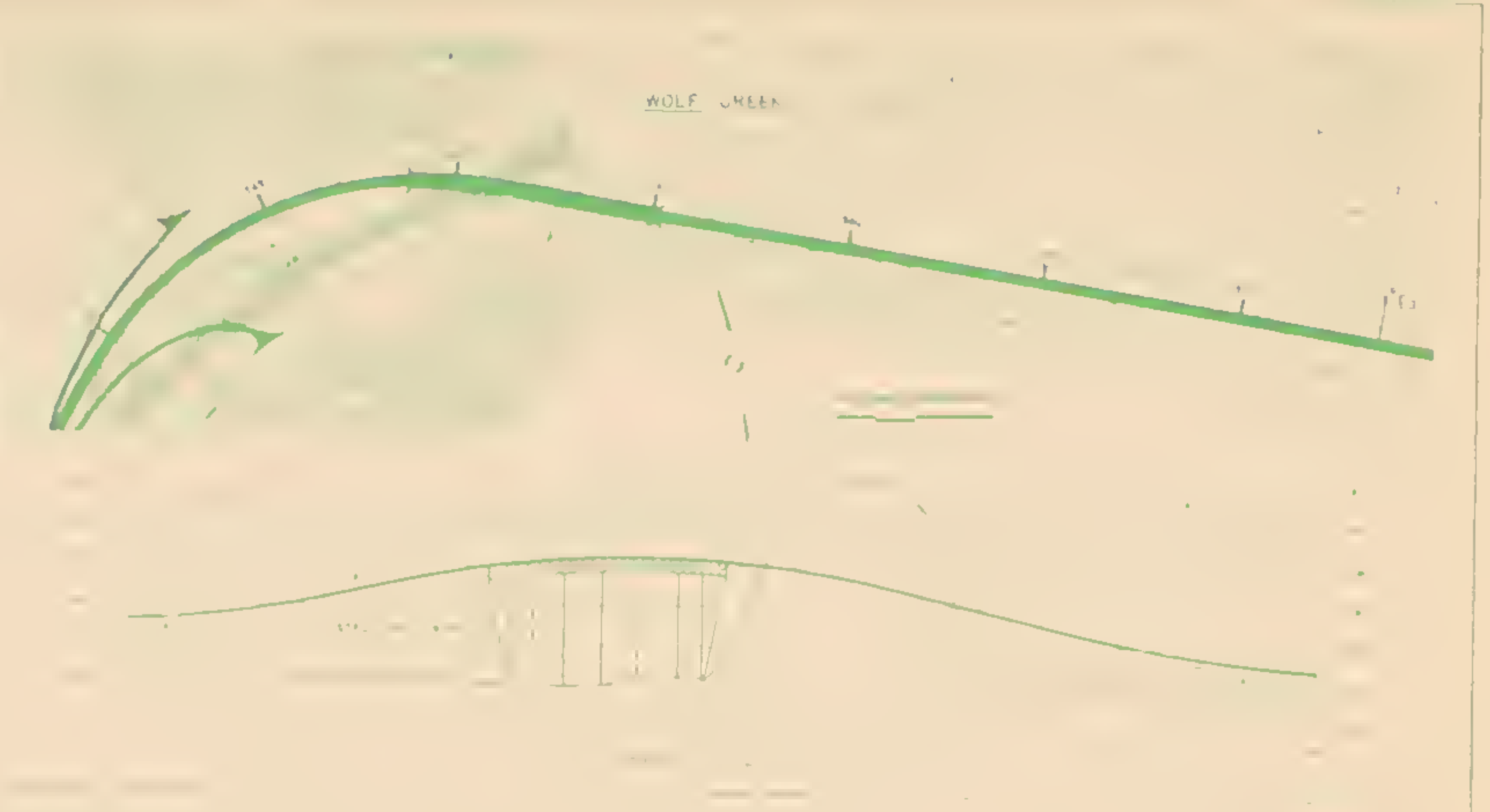
FIGURE 102 THROUGH FIGURE 115

LEGEND



LOCATION ALTERNATE L

1. STATION 2+40 TO STATION 44+90 SAME AS ALTERNATE M. REFER FIGURE [illegible]
2. STATION 44+90 TO STATION 140+00 EXHIBIT [illegible] THROUGH [illegible] FIGURE [illegible] OF [illegible]
3. STATION 140+00 TO STATION 151+00 SAME AS ALTERNATE M. REFER FIGURE [illegible]



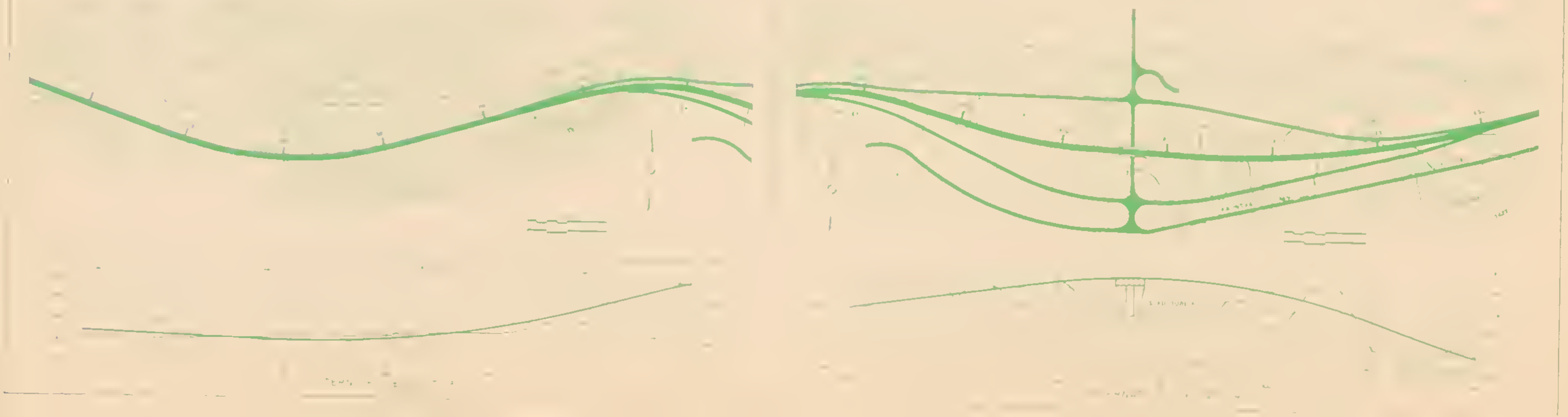
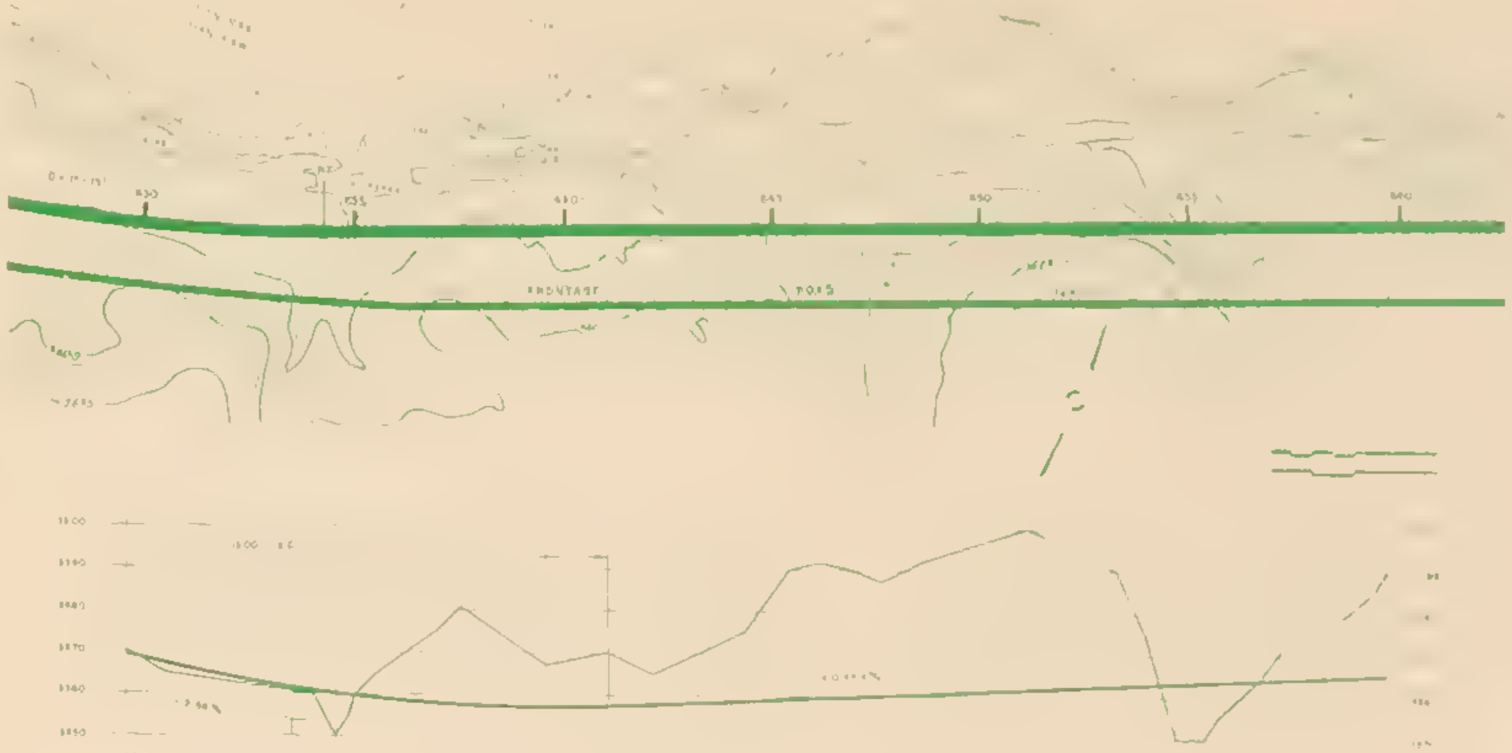
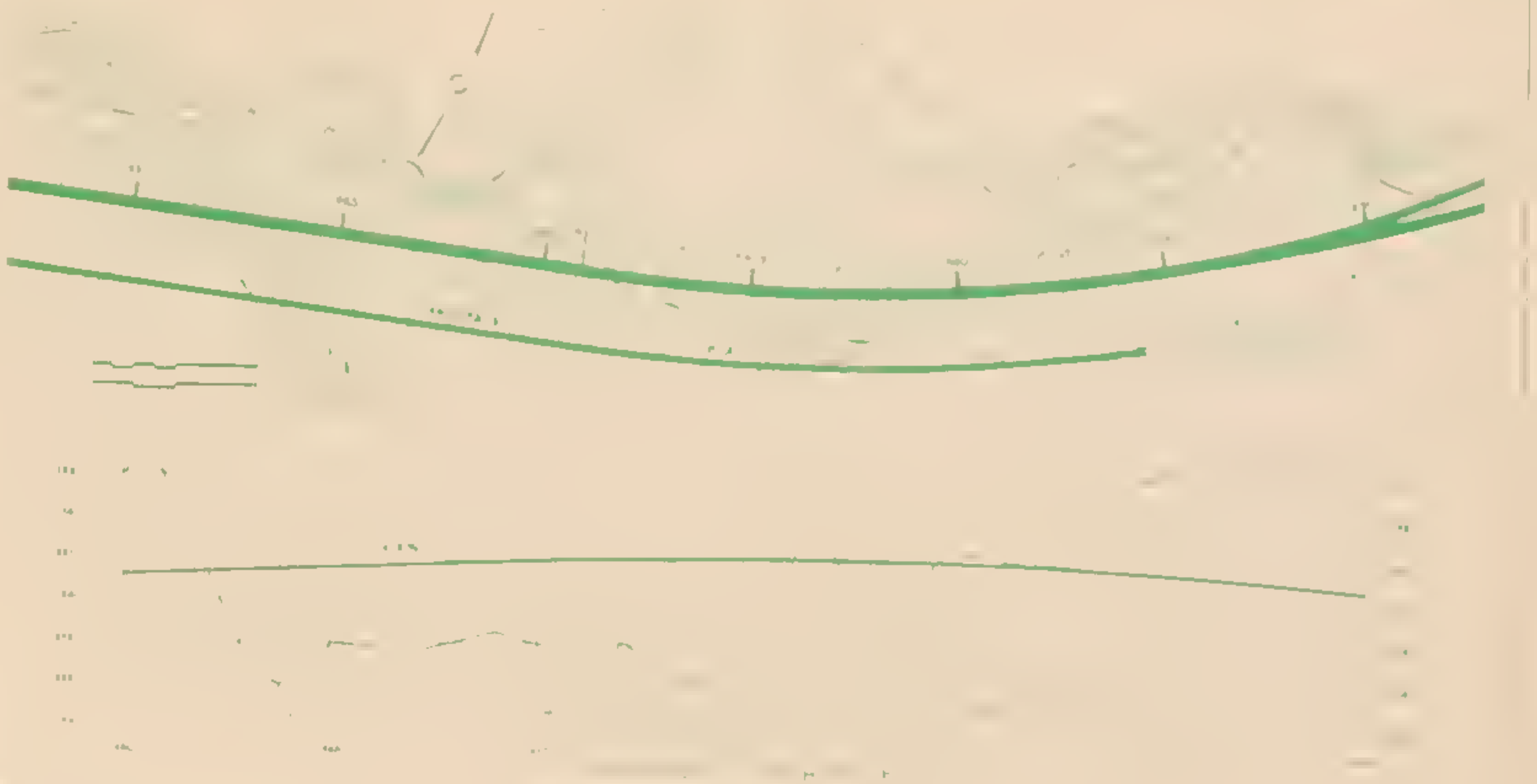
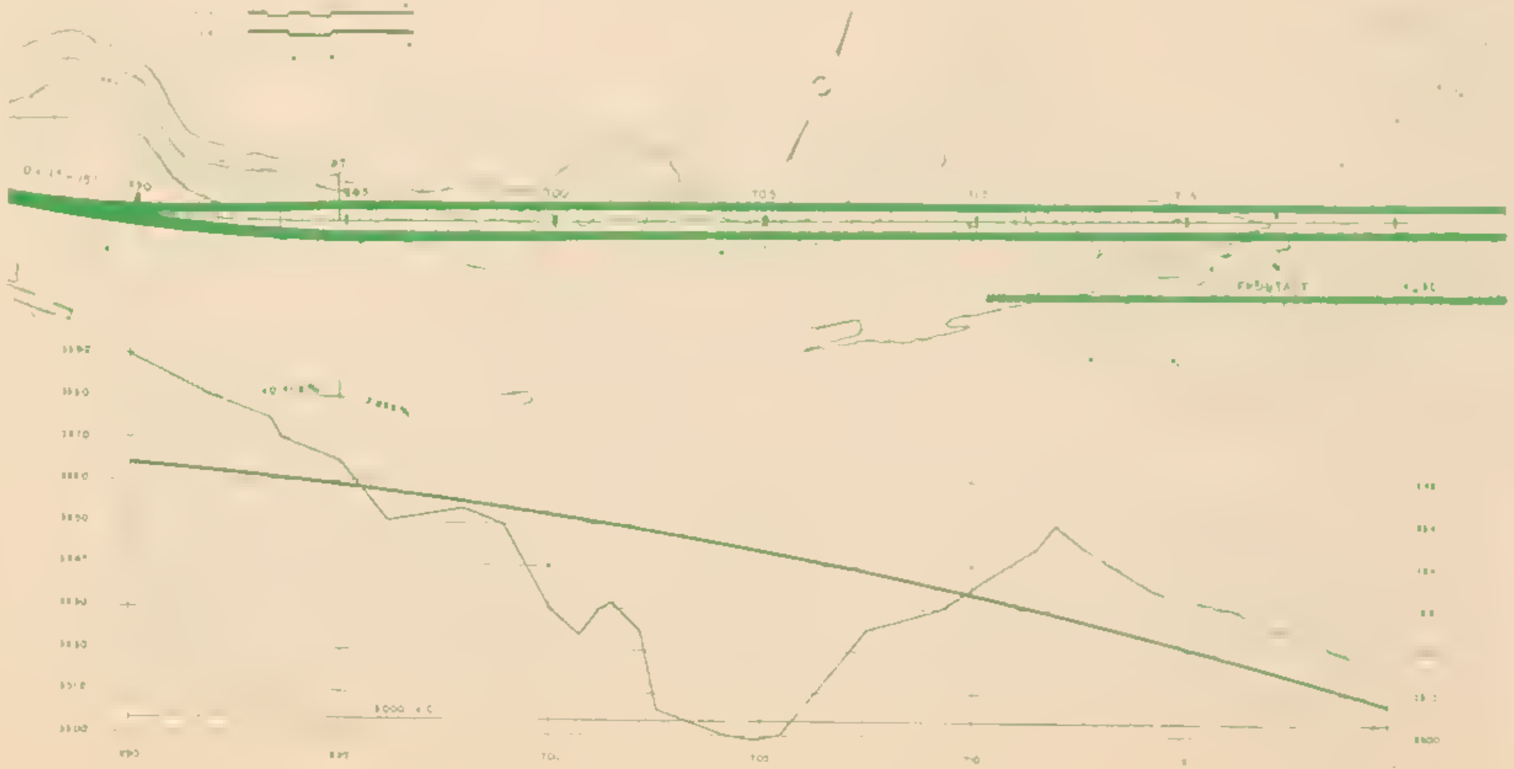


FIGURE 103

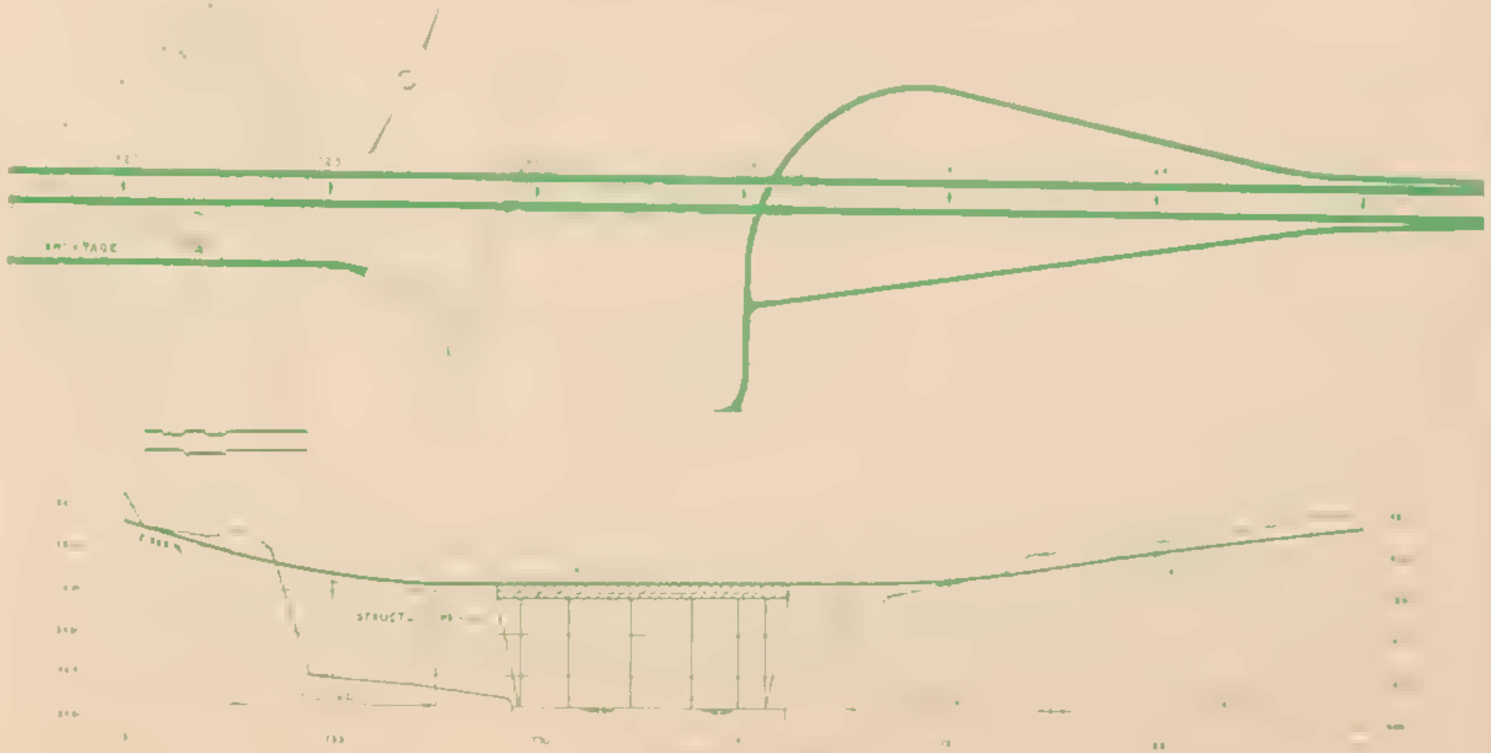


ALTERNATE I EXHIBIT



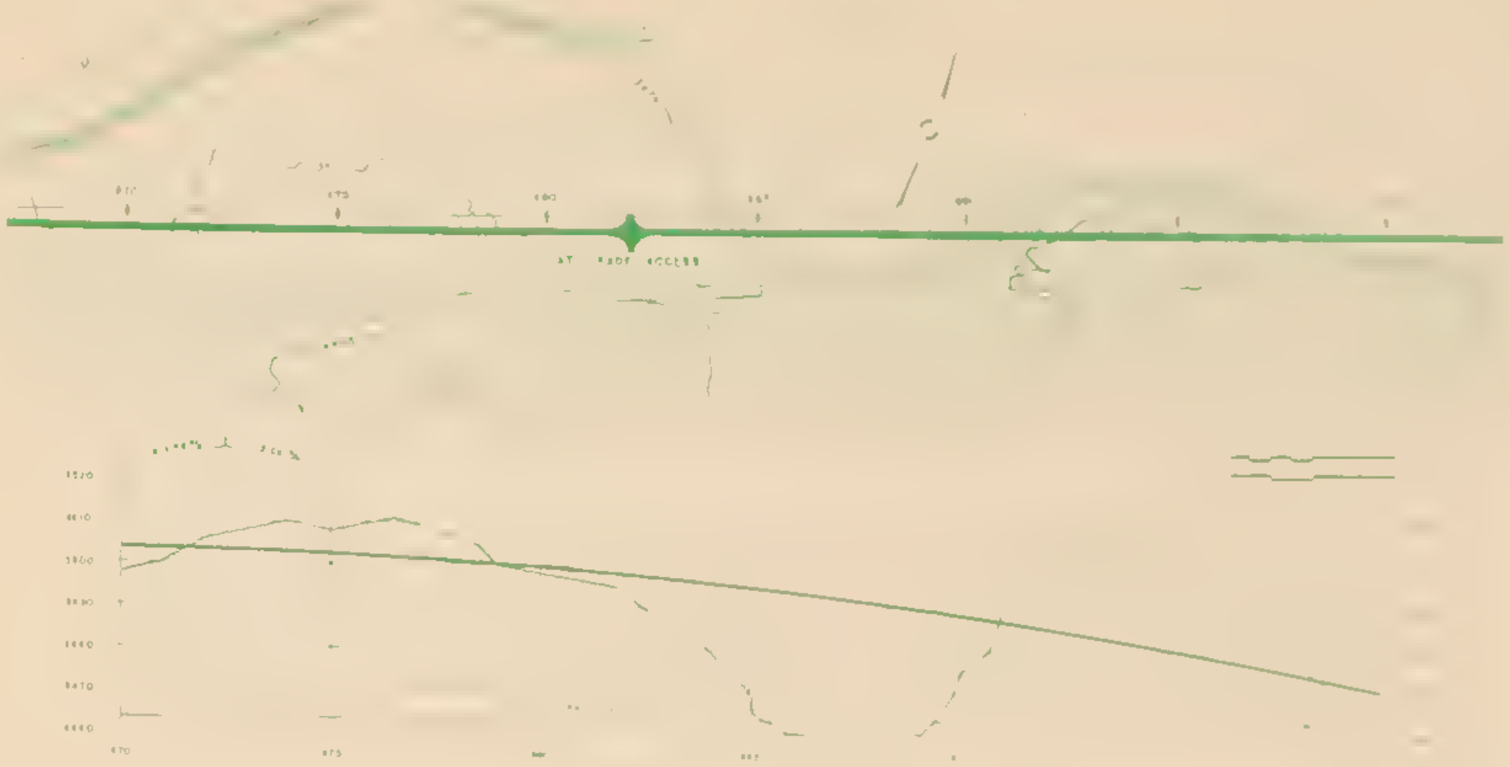


ALTERNATE L EXHIBIT 7

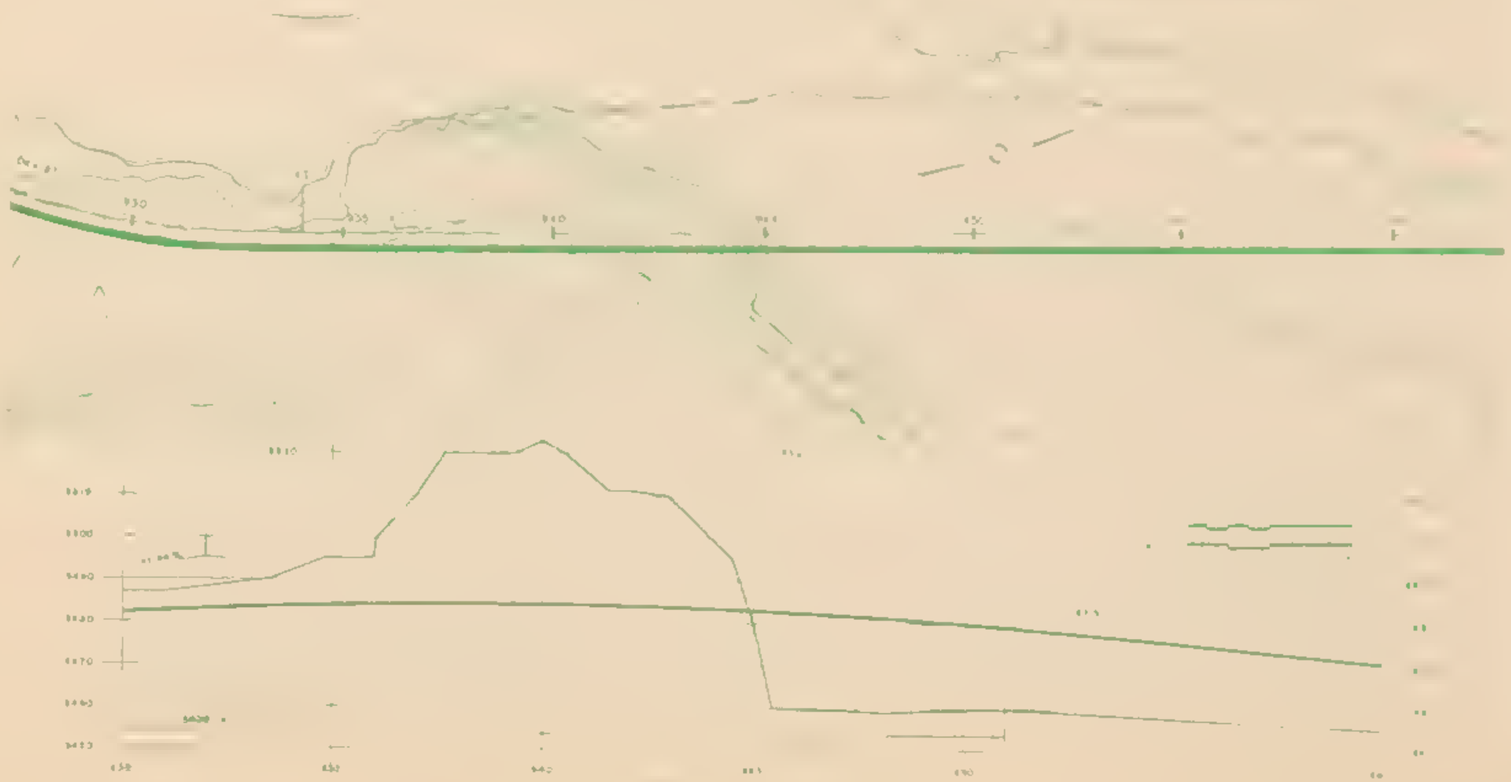


ALTERNATE L EXH

URE 04



ALTERNATE EXHIBIT 3



ALTERNATE EXHIBIT 15

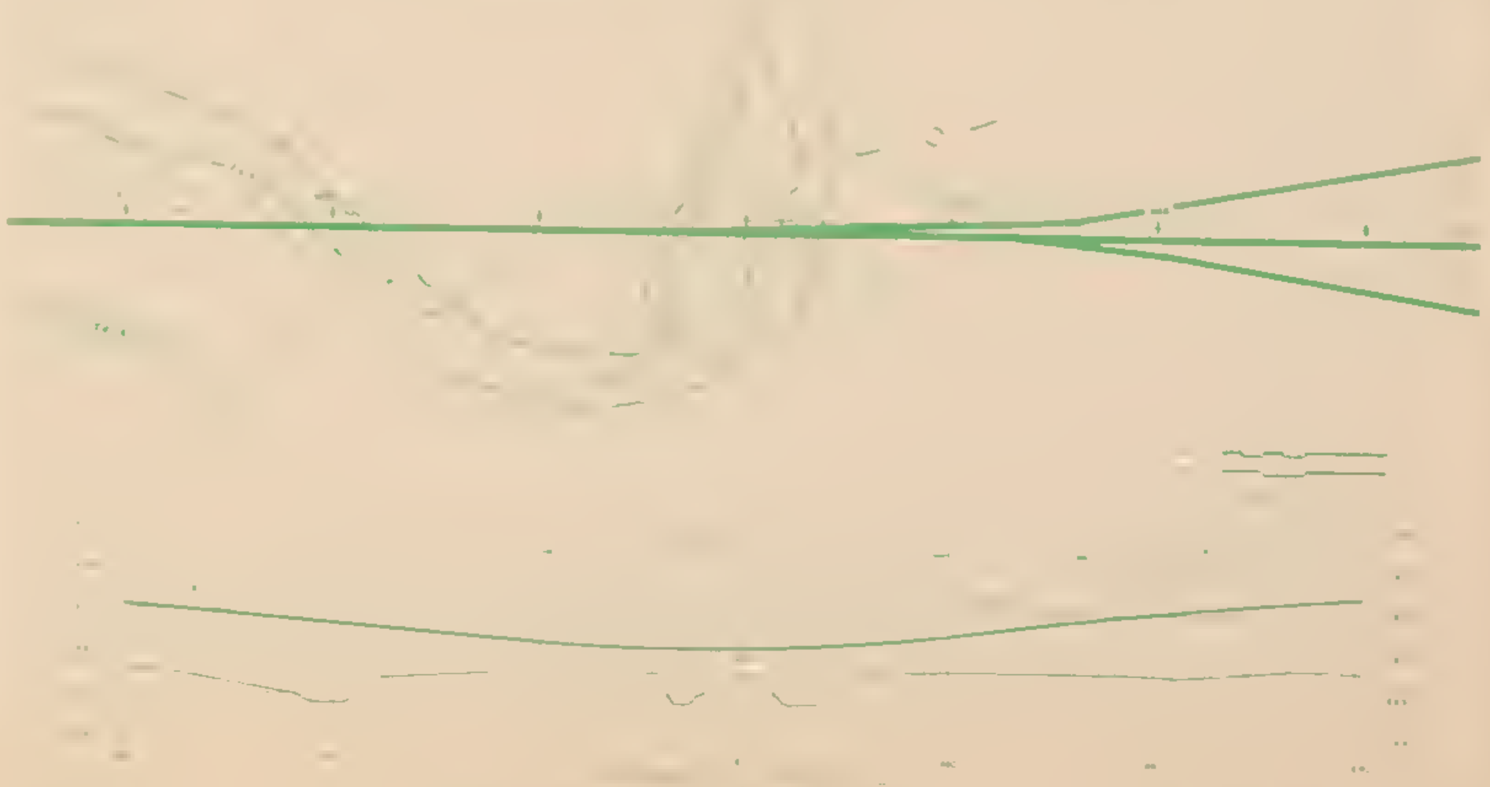


FIGURE 06

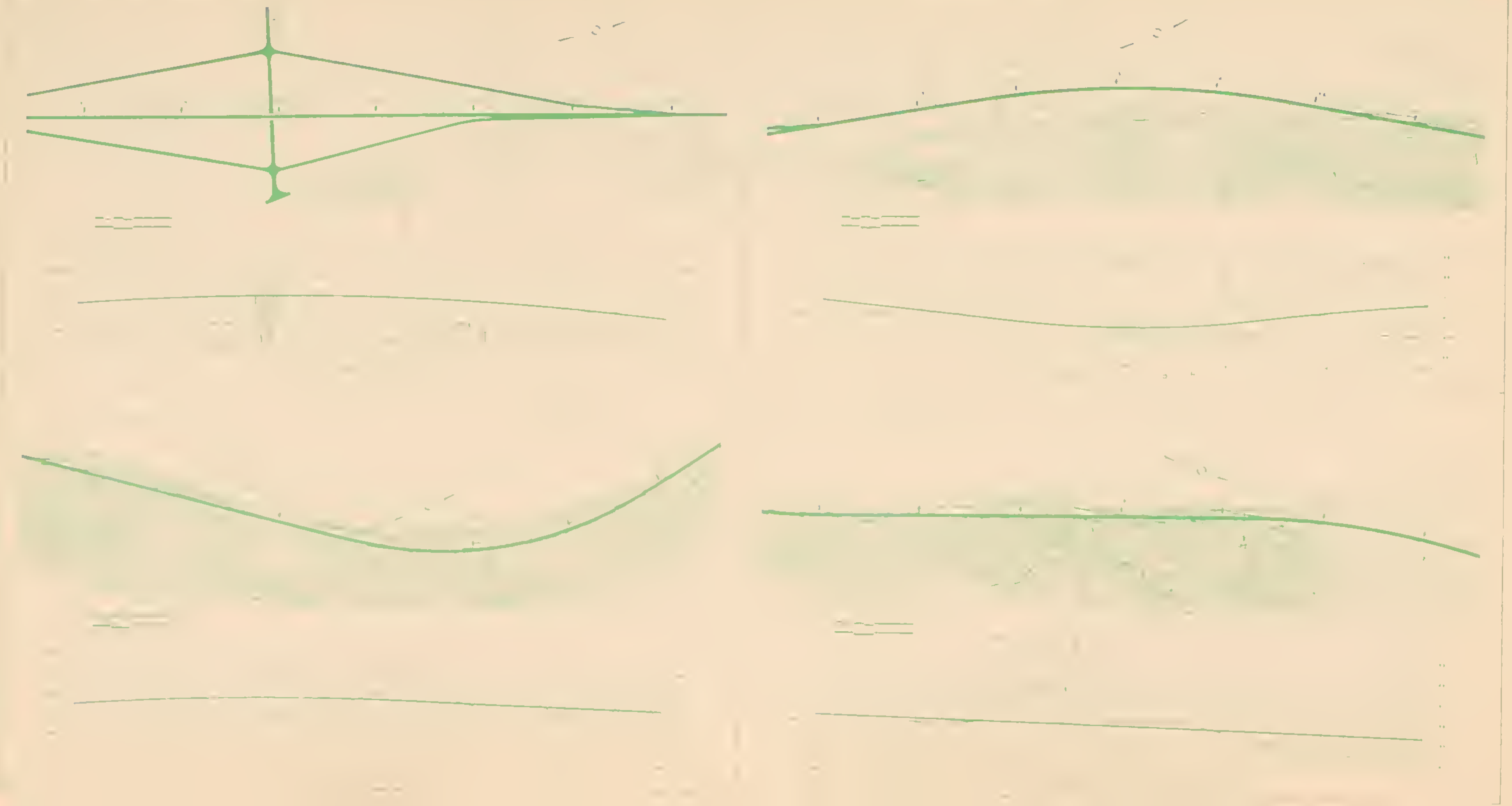
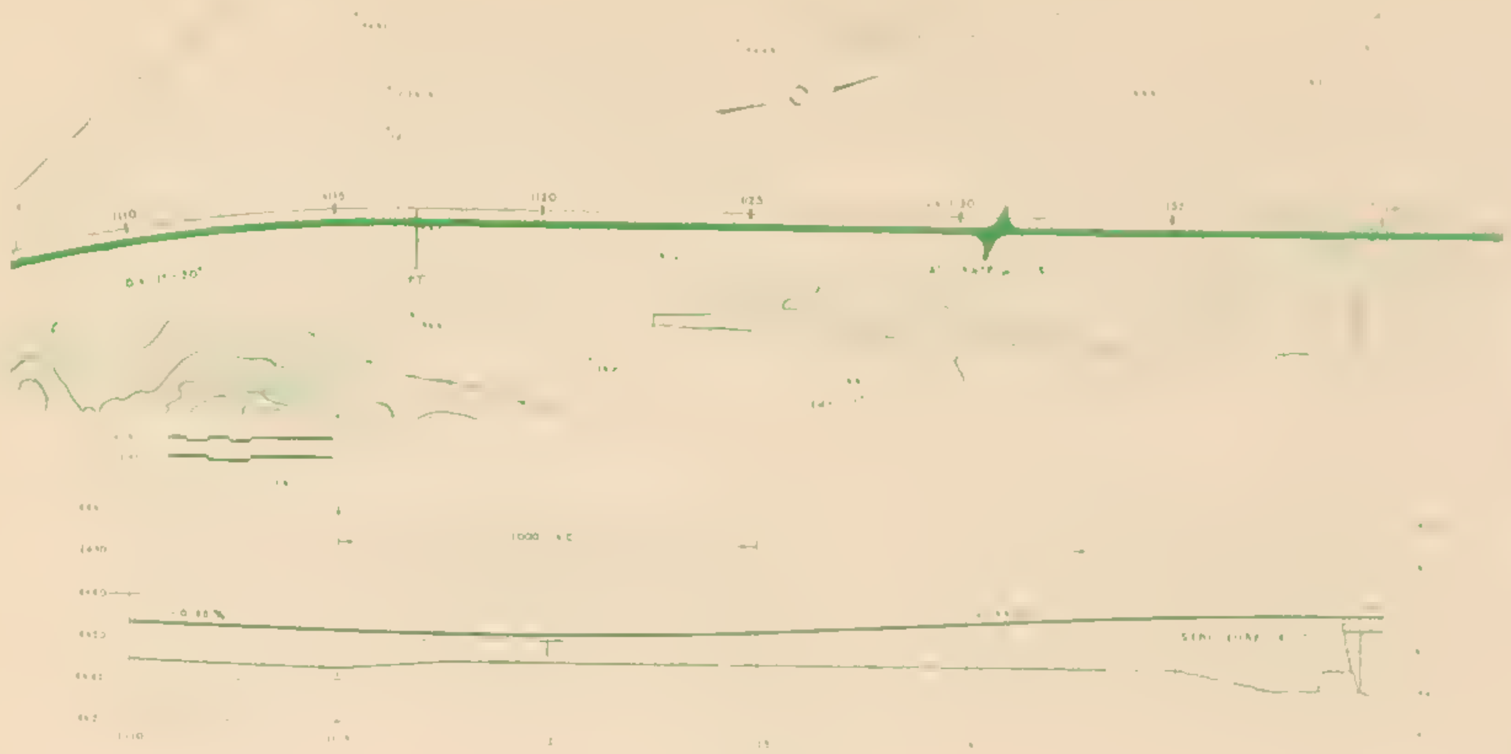


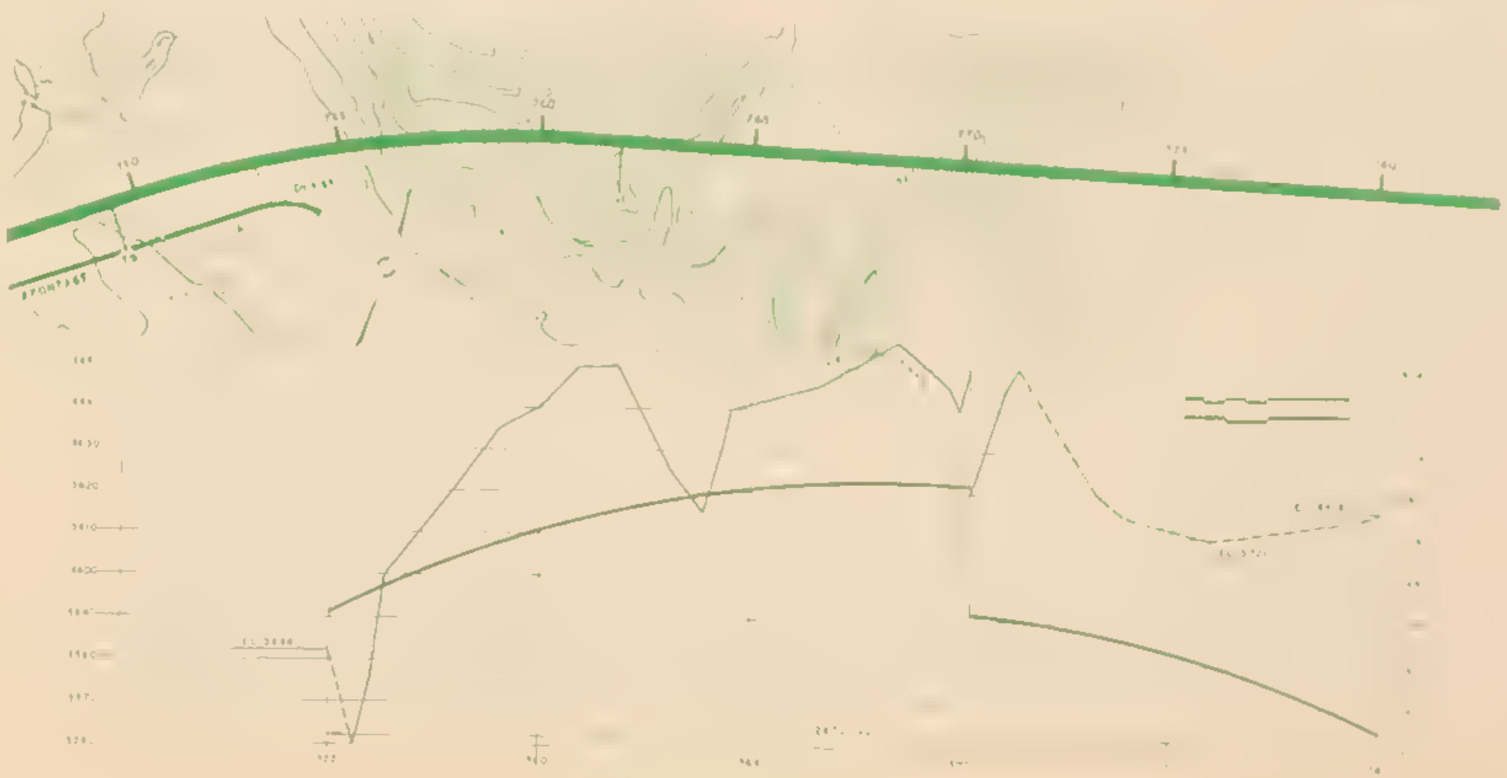
FIGURE 107

LOCATION ALTERNATE N

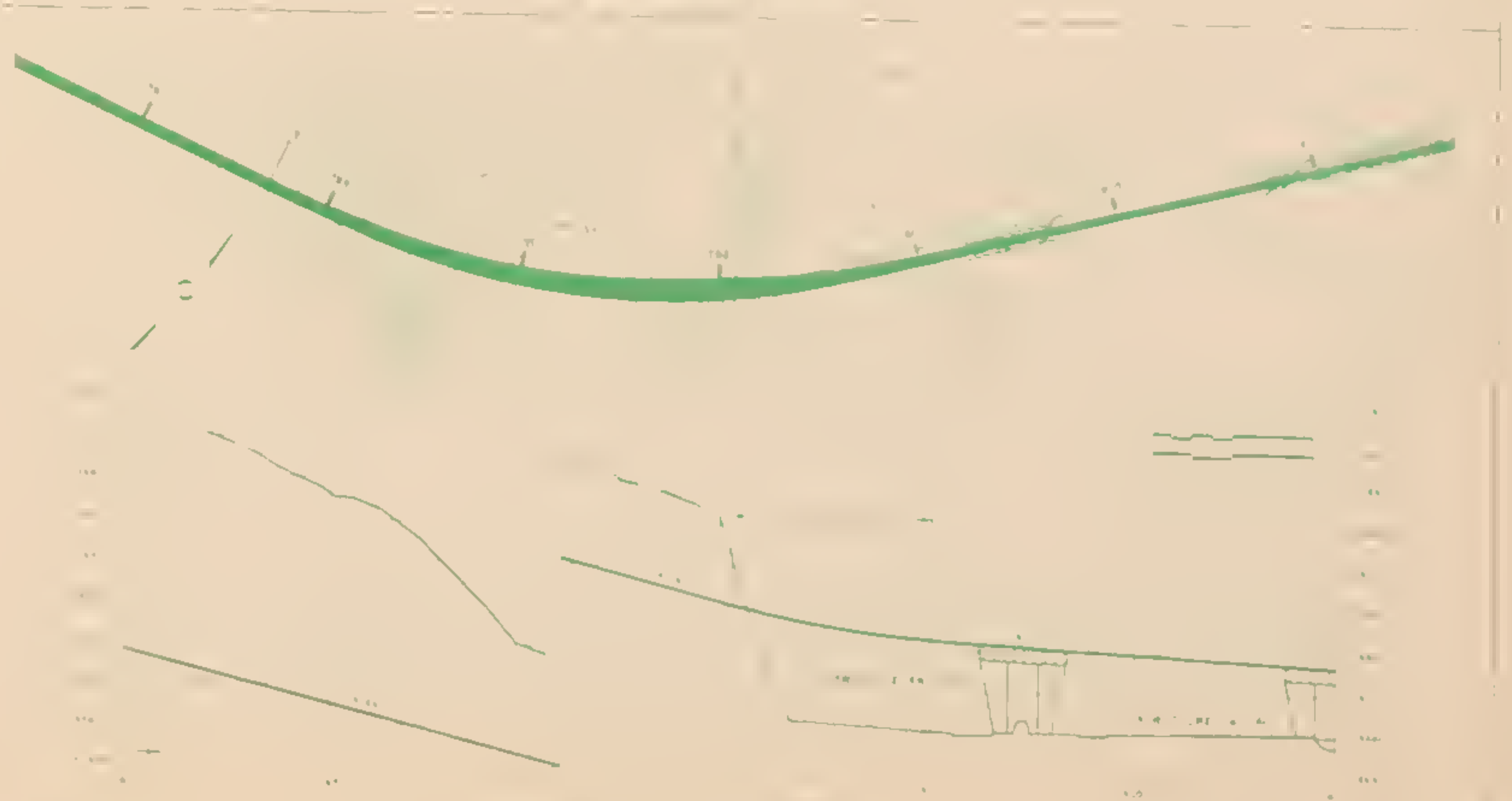
1. STATION 537+40 TO STATION 773+00 SAME AS ALTERNATE M (REFER FIGURES 2 THROUGH 91)
2. STATION 773+00 TO STATION 826+[illegible] EXHIBITS 2 THROUGH 5 IN FIGURES [illegible], 7 AND [illegible]08
3. STATION 826+ [illegible] TO STATION [illegible] SAME AS ALTERNATE [illegible] EXHIBIT [illegible] THROUGH [illegible] IN FIGURES 04 THROUGH 107



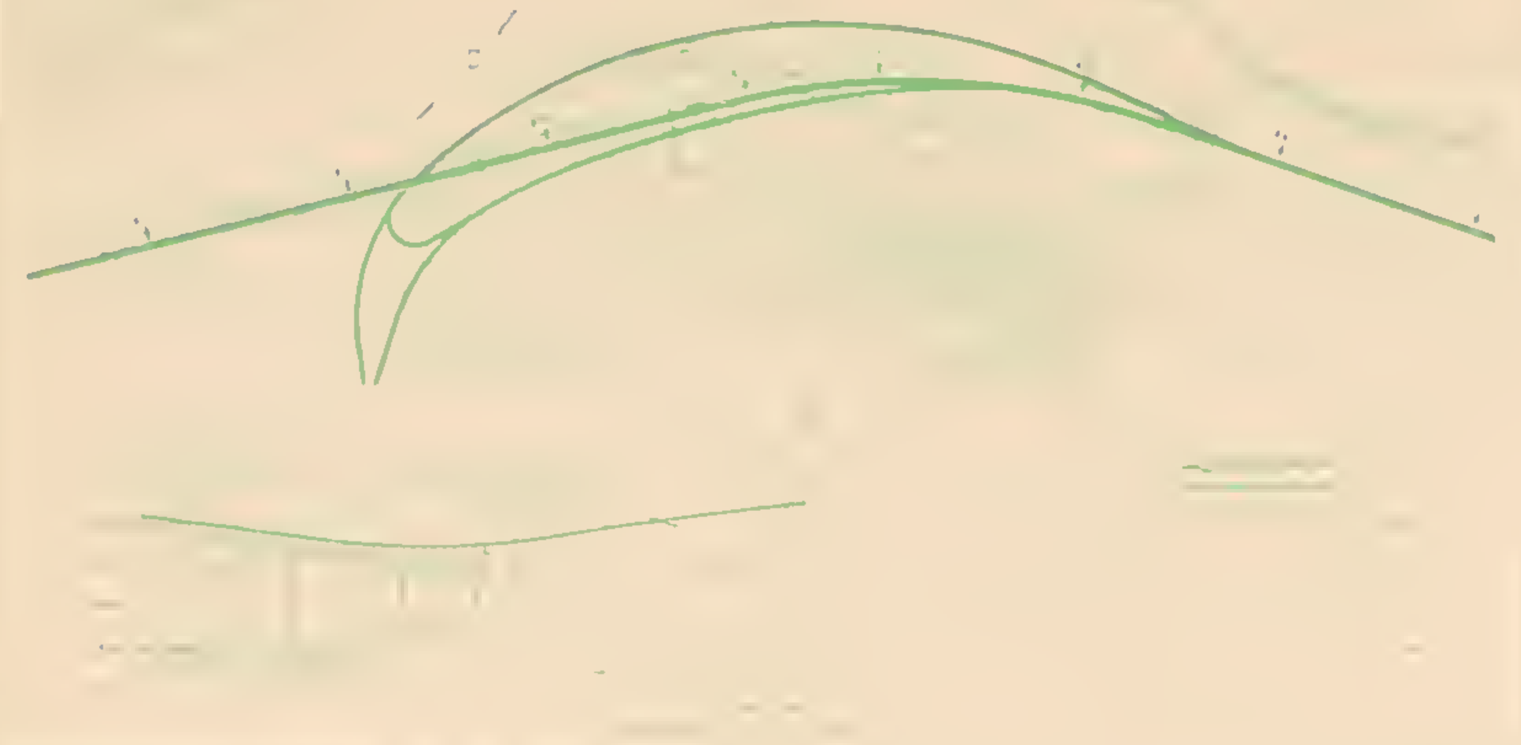
ALTERNATE L EXHIBIT 21



ALTERNATE N EXHIBIT 2



ALTERNATE N EXHIBIT 3



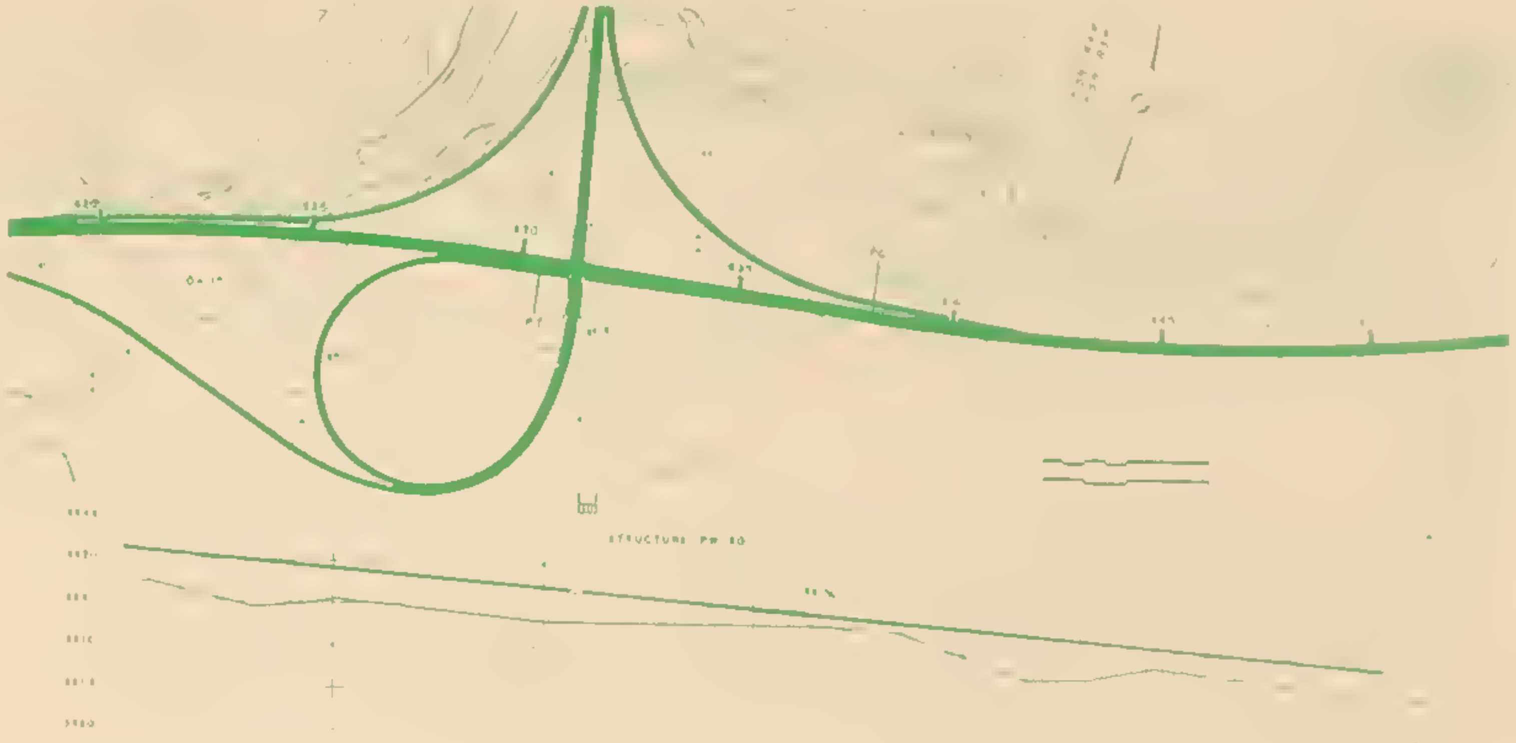
[illegible] AT ON ALTERNATE [illegible]

[illegible] TO STATION 87+00 SAME AS ALTERNATE [illegible] FIGURE [illegible] THROUGH [illegible] ATION 74+[illegible] EXHIBITS 2 THROUGH 9 ON FIGURE 08 THROUGH [illegible] 74+[illegible] TO STATION [illegible] SAME AS ALTERNATE [illegible] ON EXHIBIT [illegible] 0 THROUGH [illegible] ON [illegible] THROUGH [illegible]

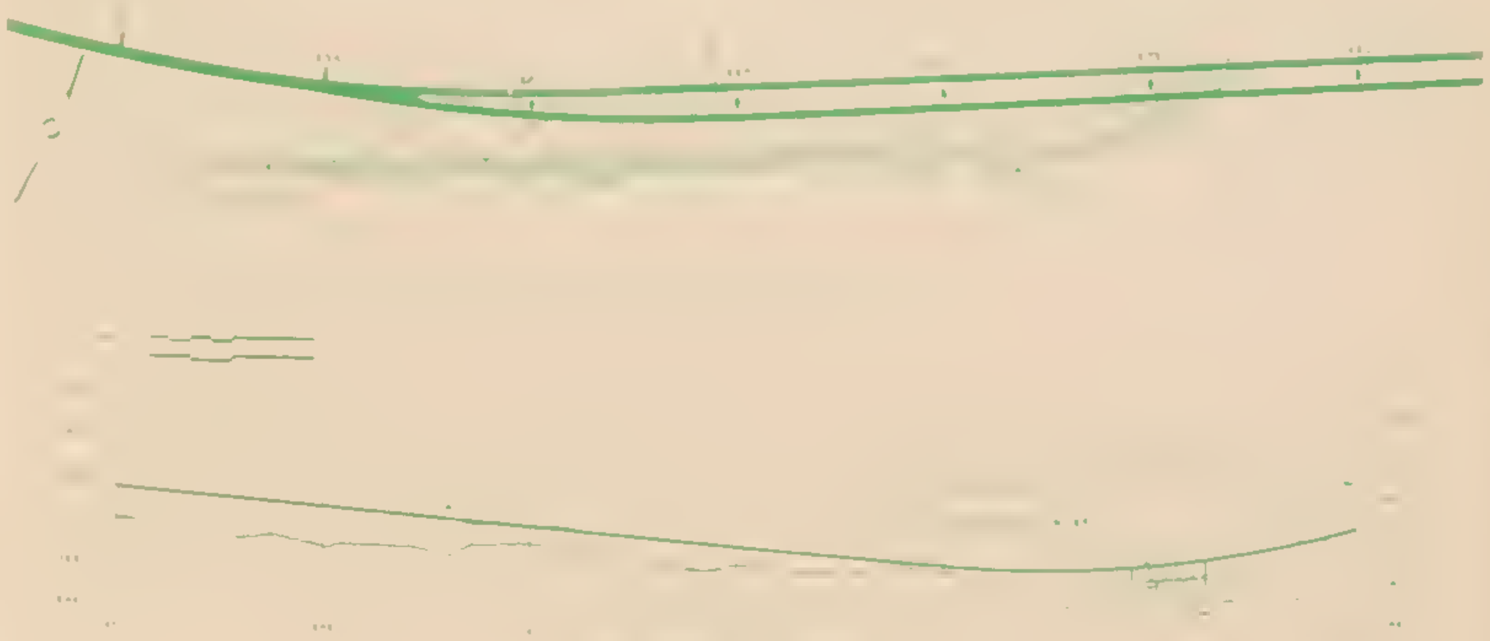
[illegible] EXHIB [illegible]

ALTERNATE [illegible] EXHIB [illegible] 3

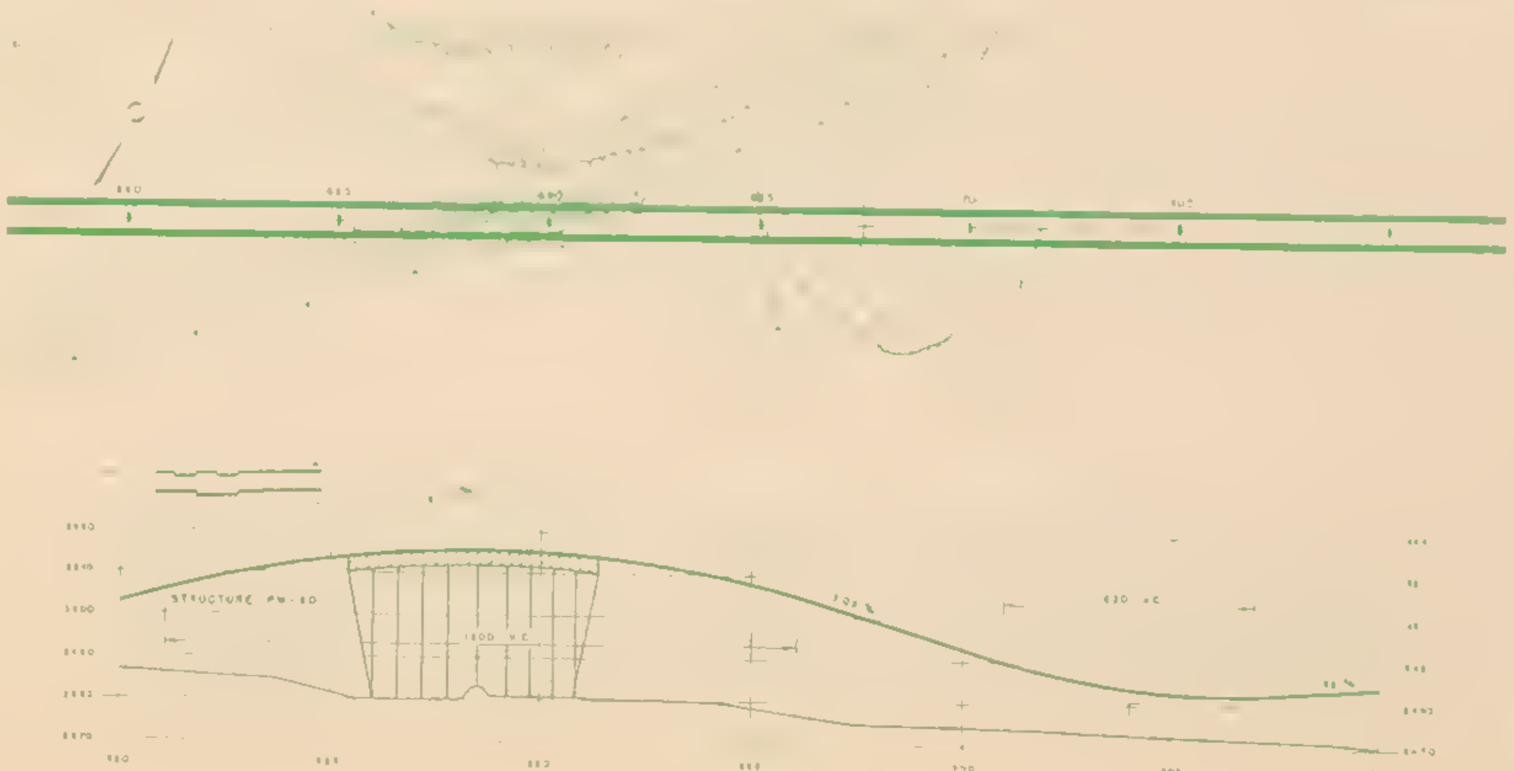
FIGURE 19



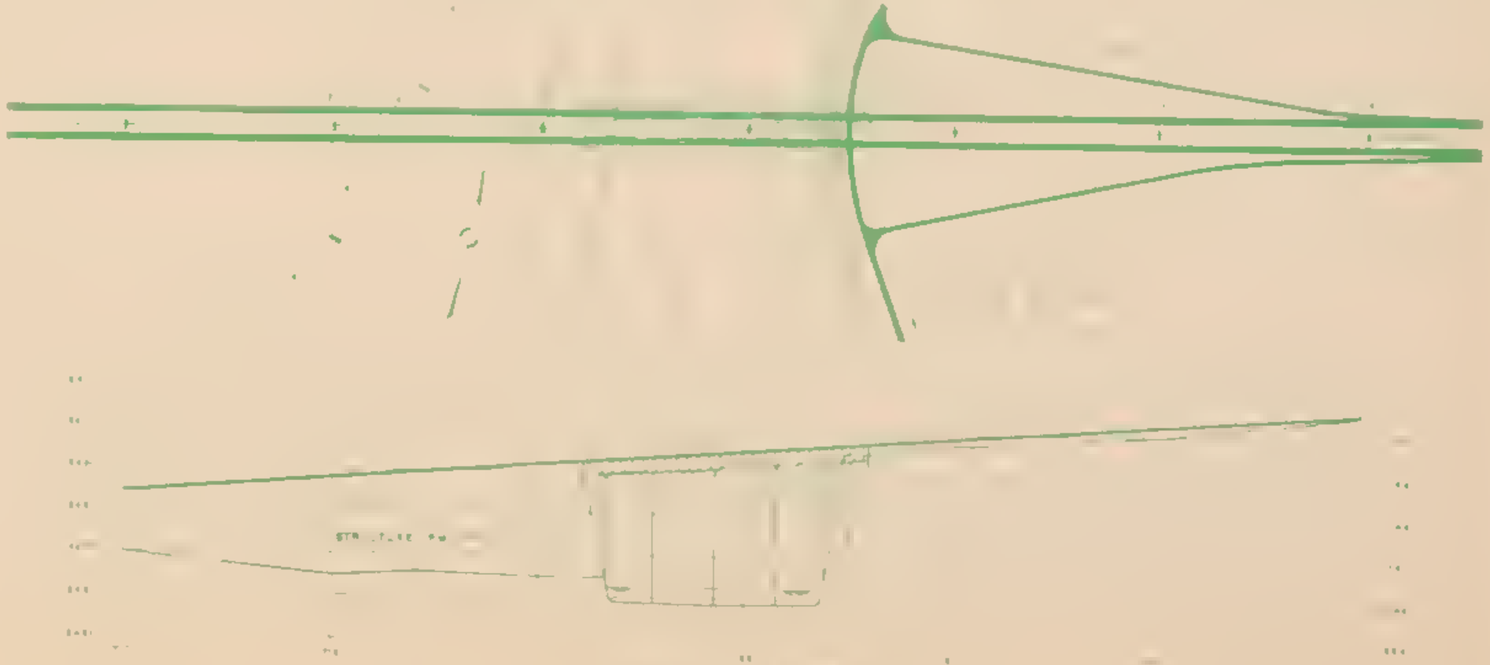
ALTERNATE G EXHIBIT 4



[illegible] 5

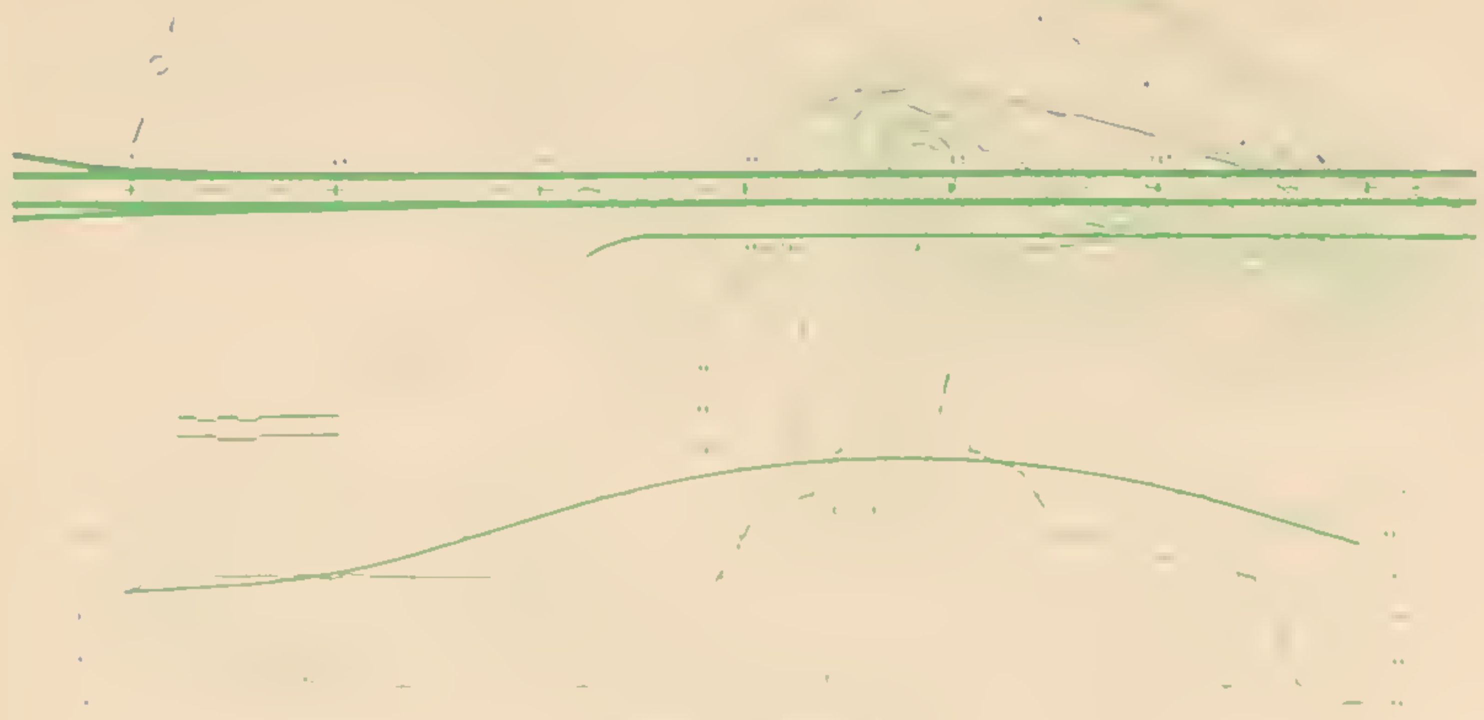


ALTERNATE O EXHIBIT 5



ALTERNATE [illegible] 7

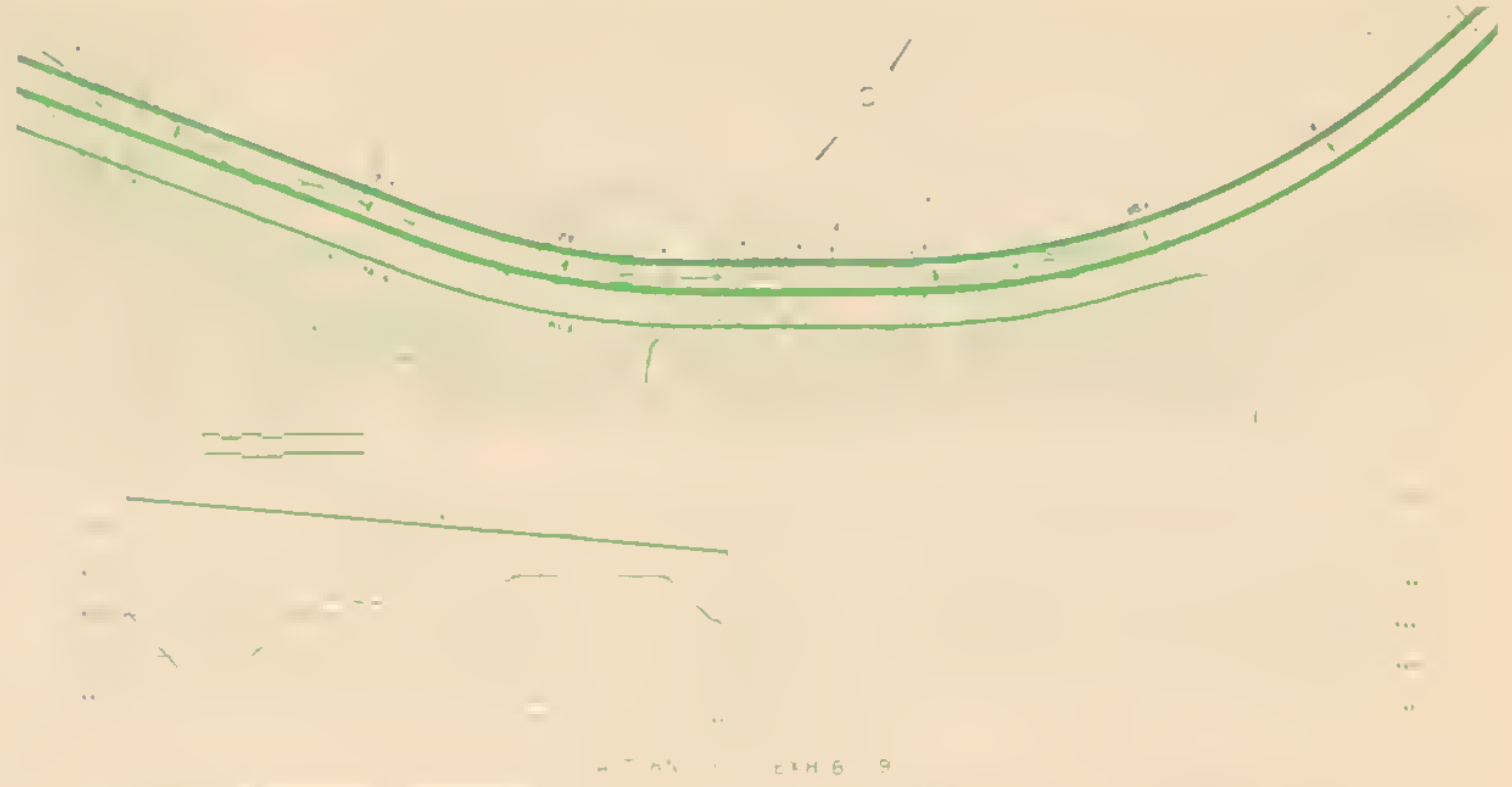
FIGURE 110



[illegible]

[illegible]

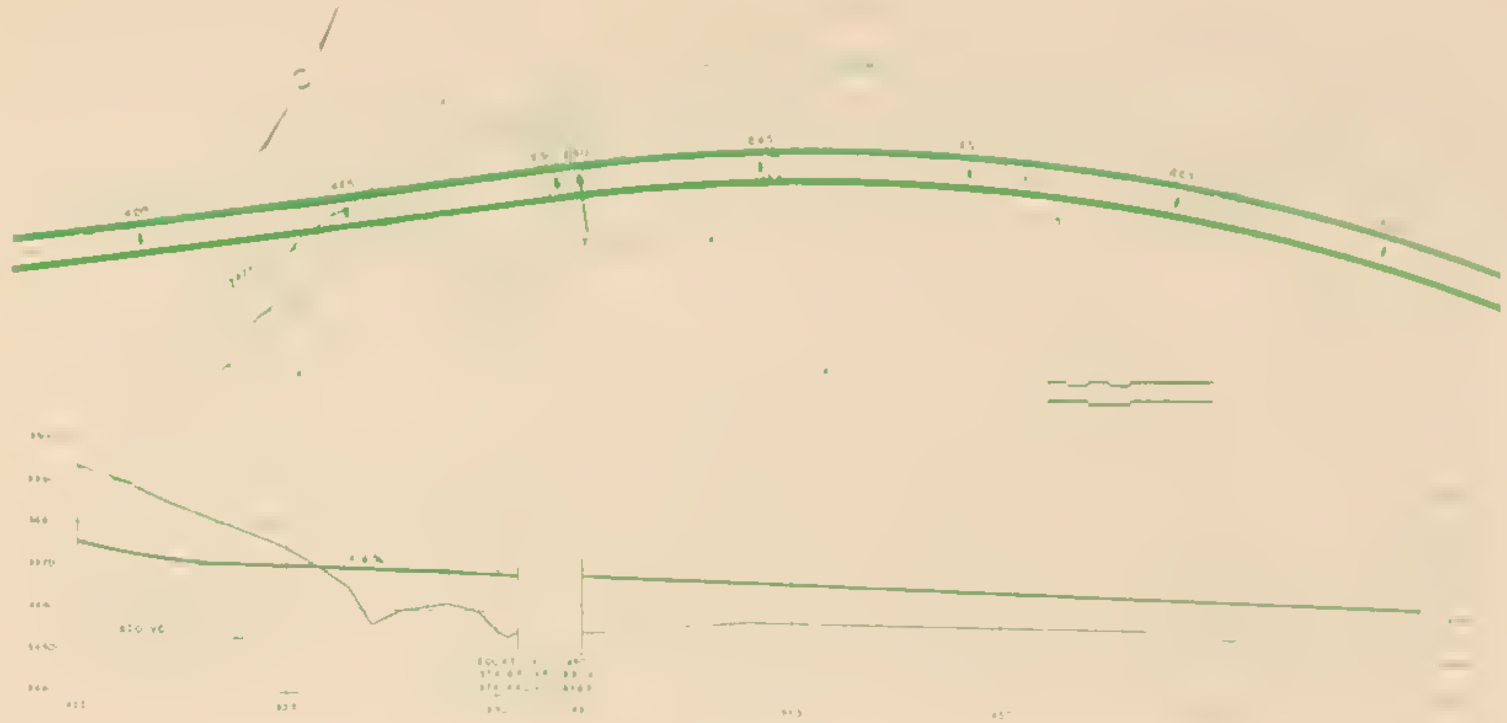
[illegible]



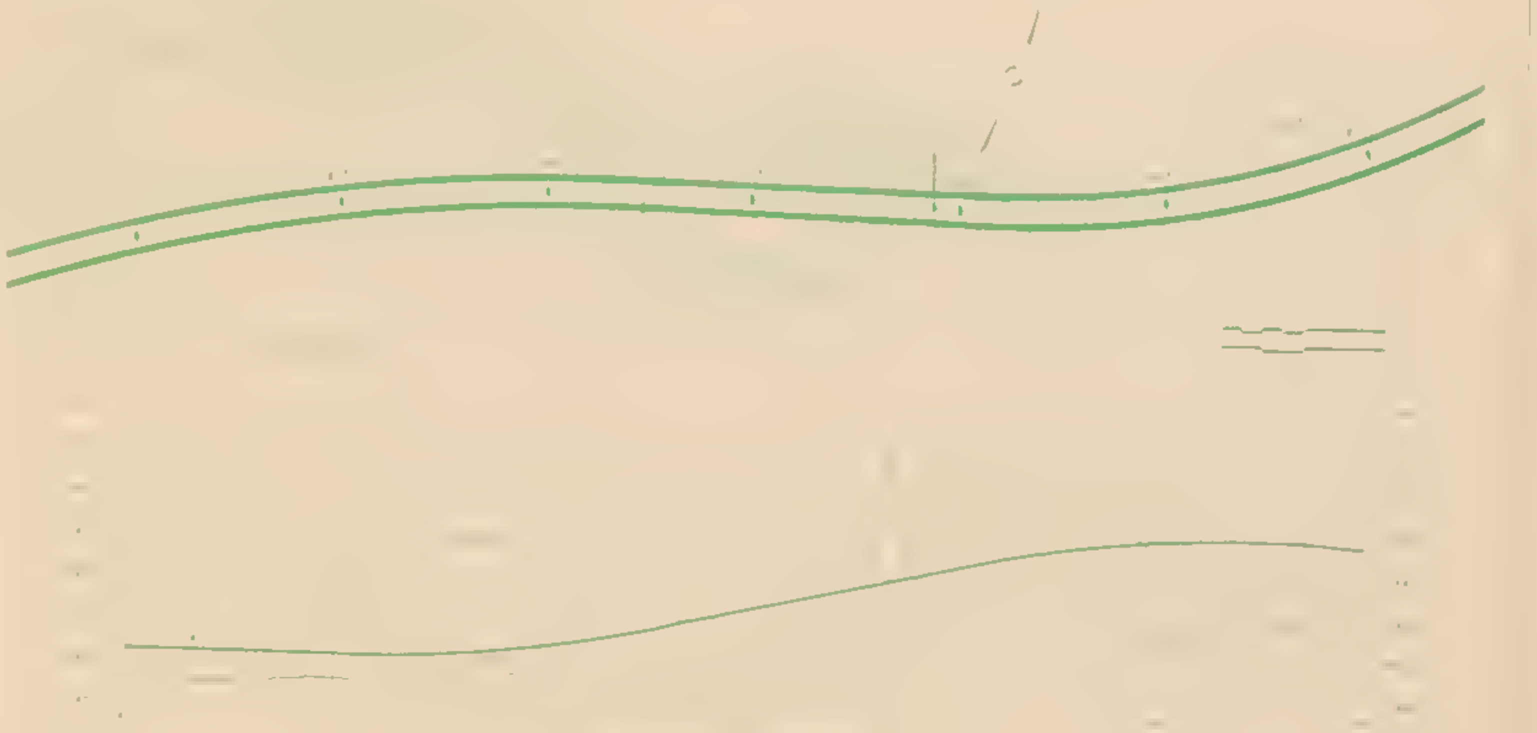
[illegible]

[illegible]

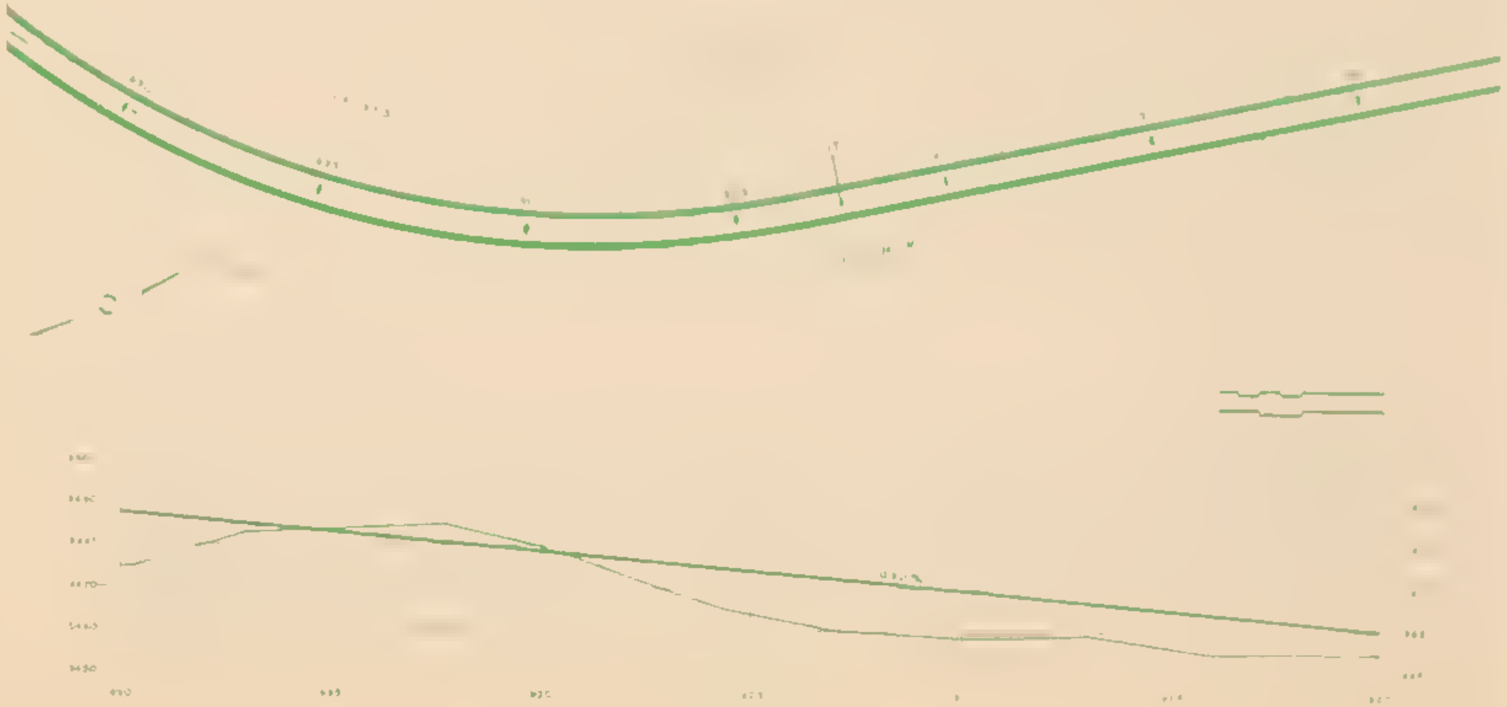
F . RE



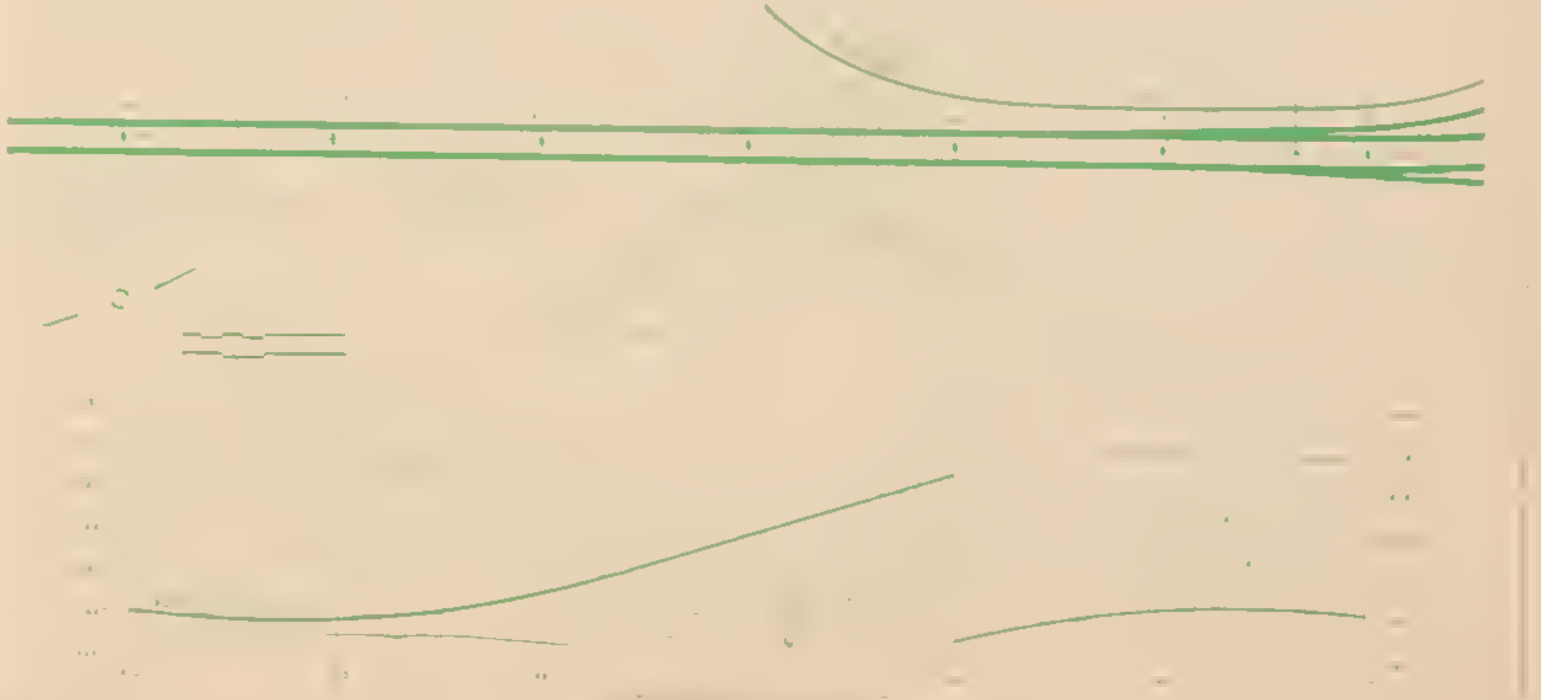
ALTERNATE P EXHIBIT 3



[illegible] 4

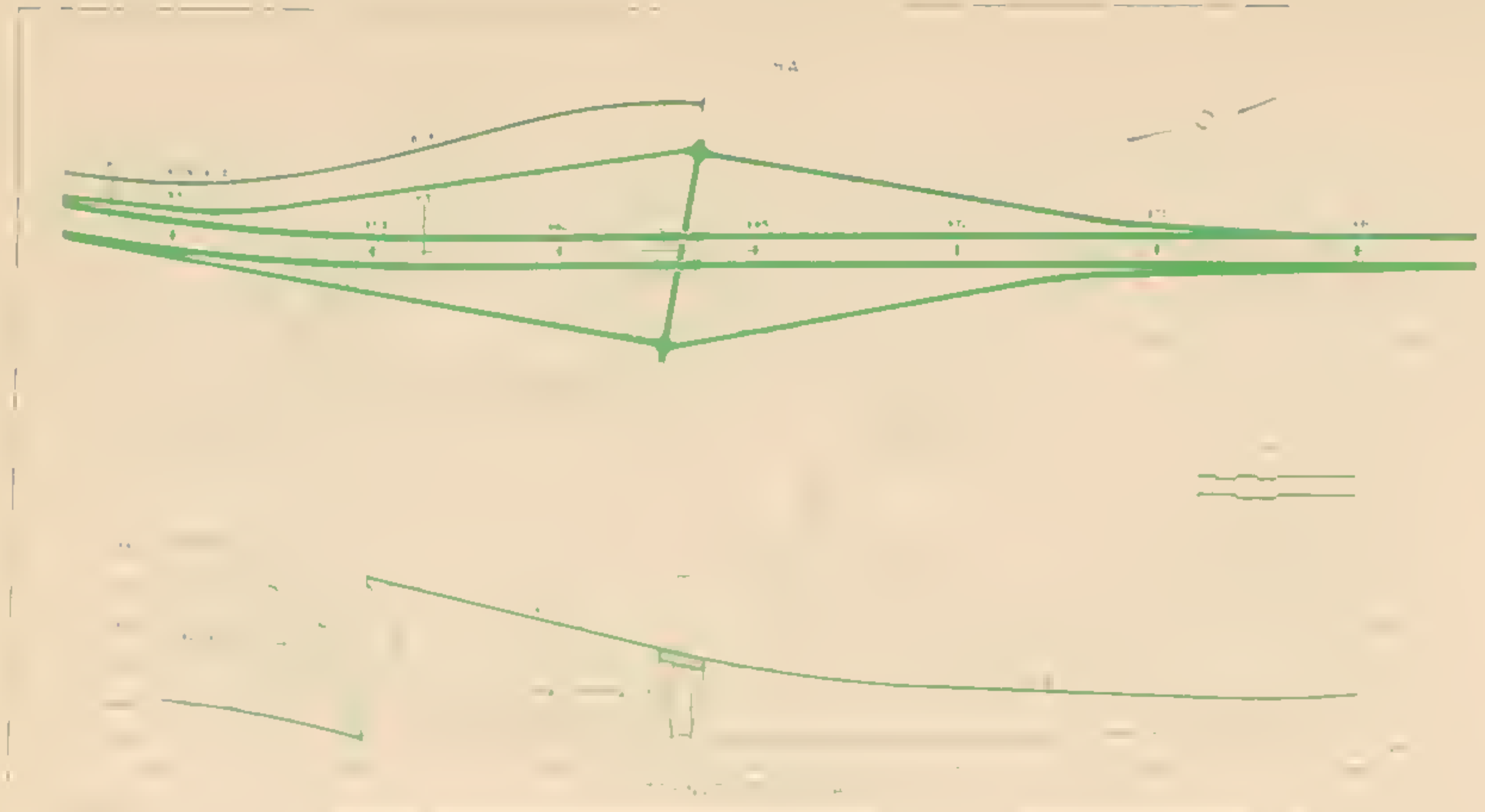


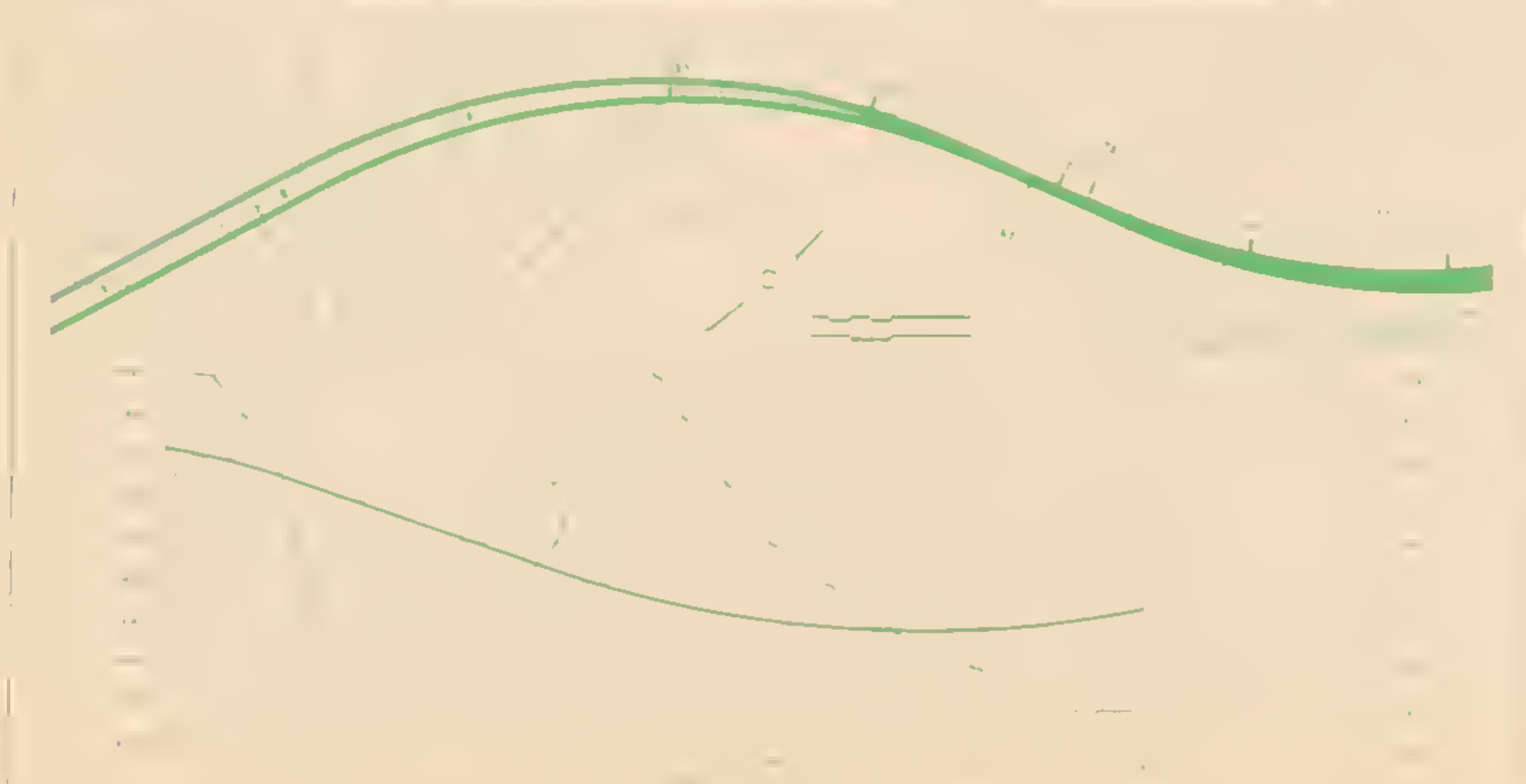
ALTERNATE P EXHIBIT 5

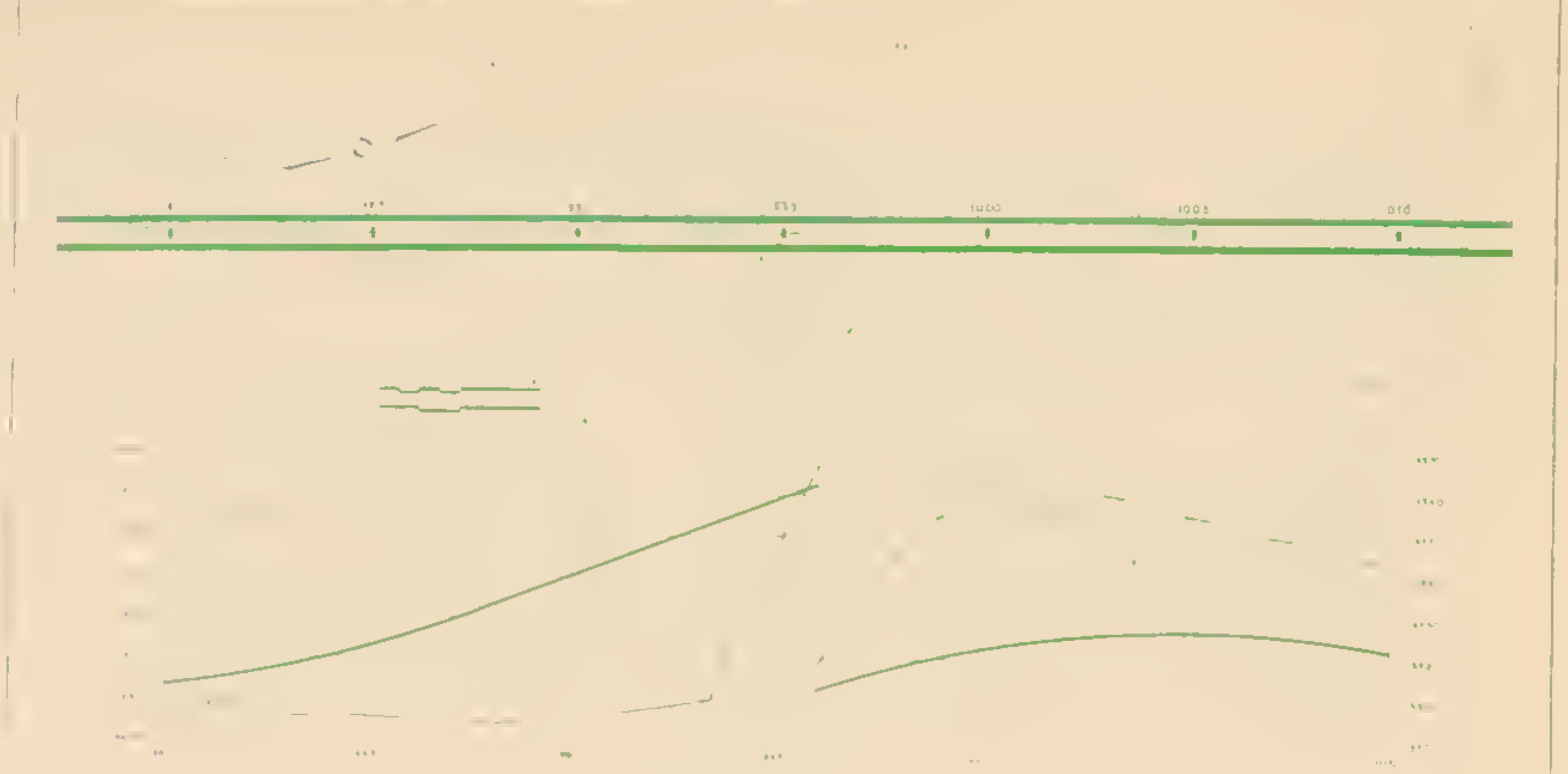


[illegible] 6

FIGURE 112







ALTERNATE P EXHIBIT 8

LOCATION ALTERNATE Q

STATION 537 + 40 TO STATION 576 + 00 SAME AS ALTERNATE M (REFER FIGURES 2 THROUGH 4)

2 STATION 576 + 00 TO STATION 655 + 00 SAME AS ALTERNATE O EXHIBITS 2 THROUGH 4 ON FIGURES 08 AND 09

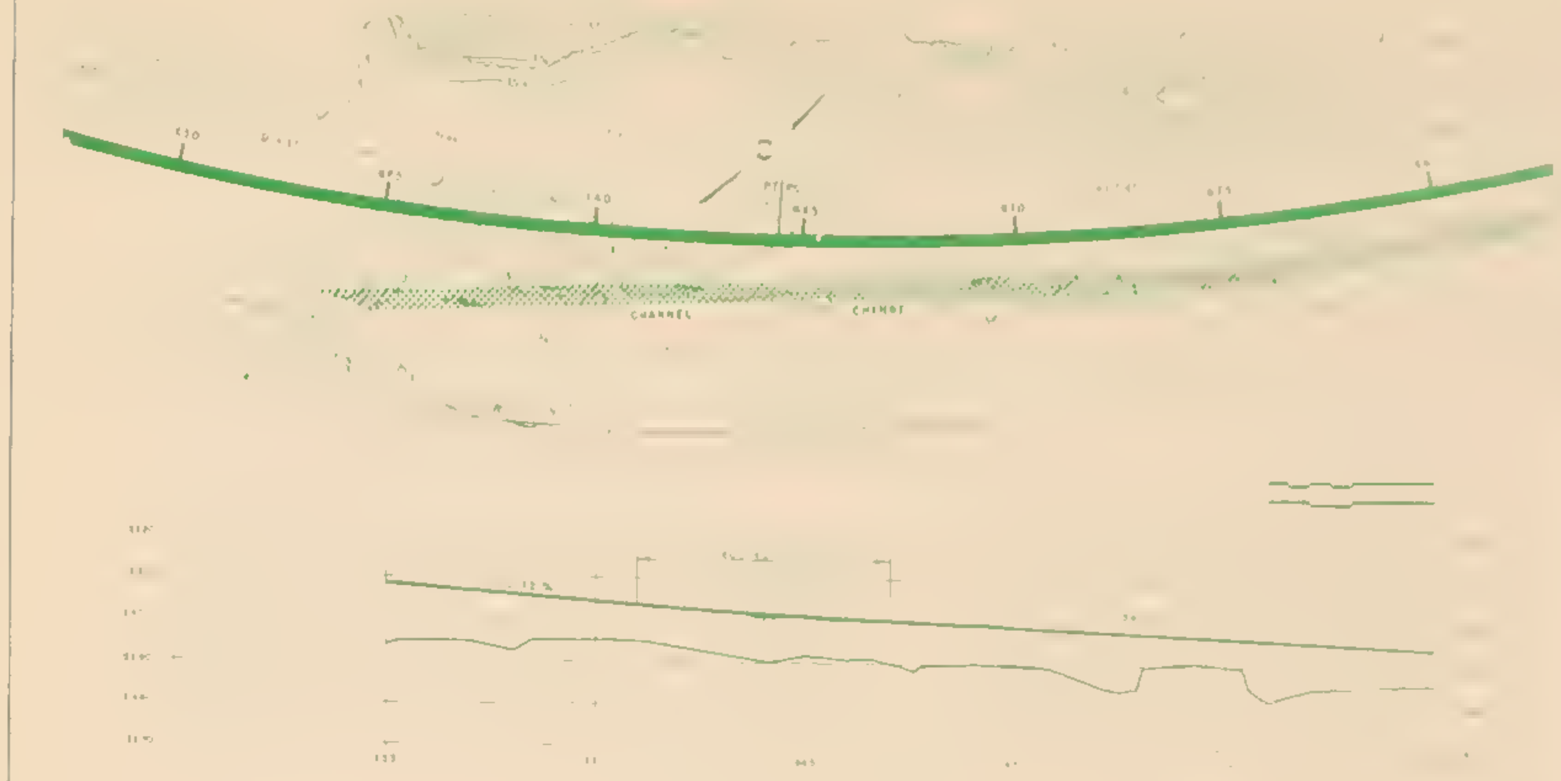
3 STATION 655 + 00 TO STATION 840 + 00 EXHIBITS 2 THROUGH 8 ON FIGURES 113 AND 114

4 STATION 840 + 00 TO STATION 1034 + 25 SAME AS ALTERNATE P EXHIBITS 3 THROUGH 9 ON FIGURES 111 AND 112

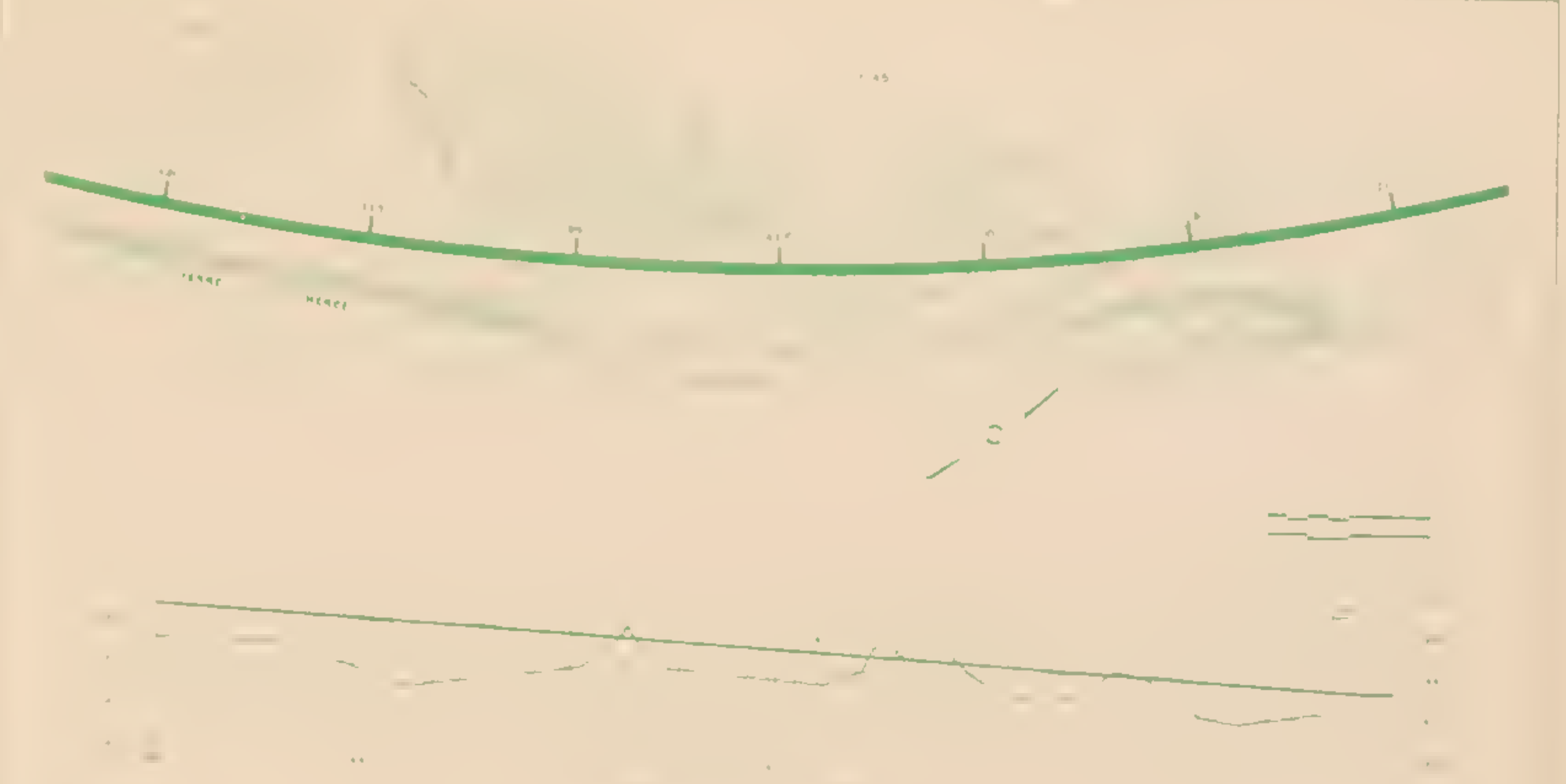
STATION 1034 + 25 TO STATION 15[illegible] + 00 SAME AS ALTERNATE M (REFER FIGURES 18 THROUGH 21)

ALTERNATE Q EXHIBIT

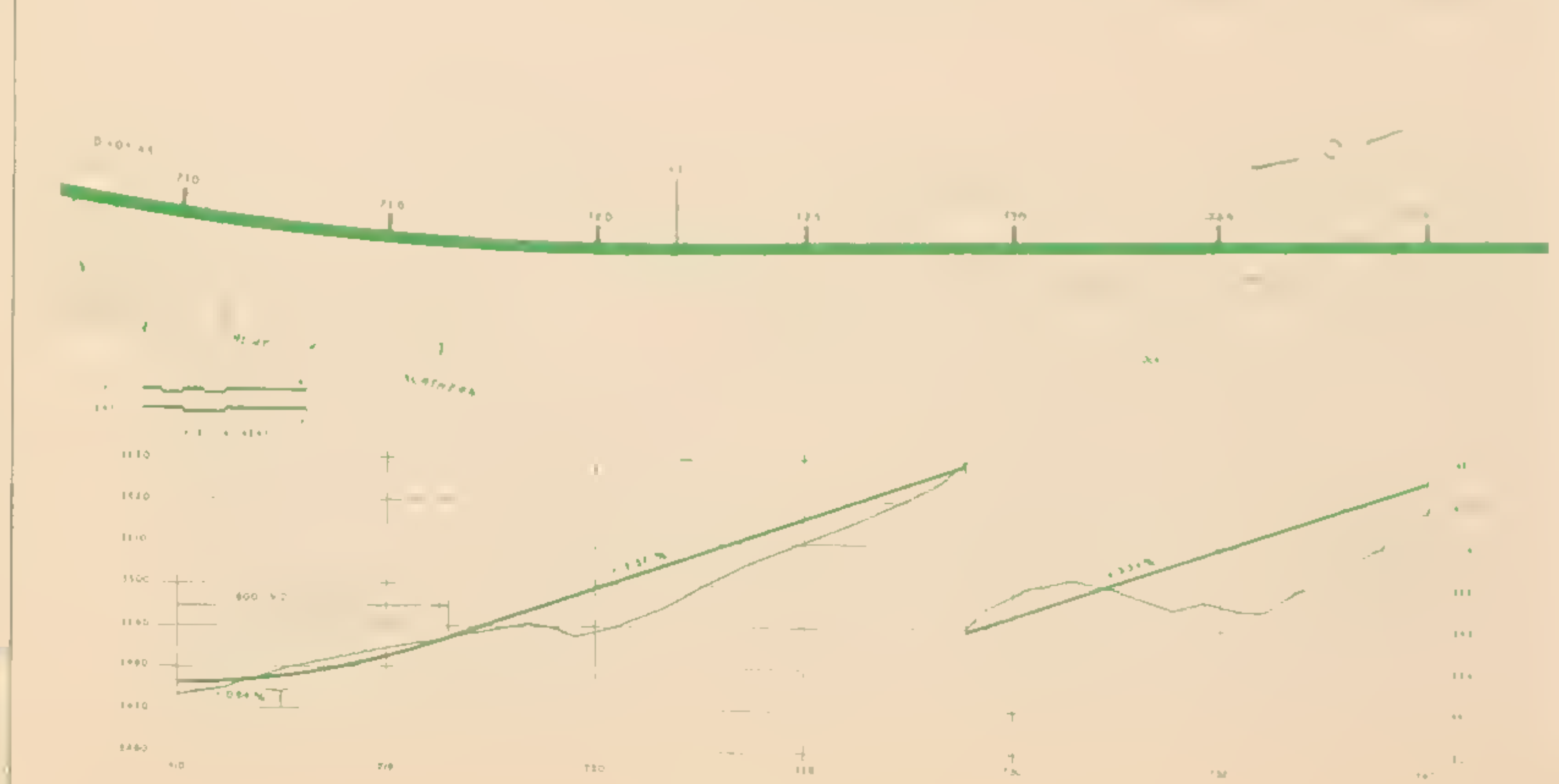
FIGURE 3



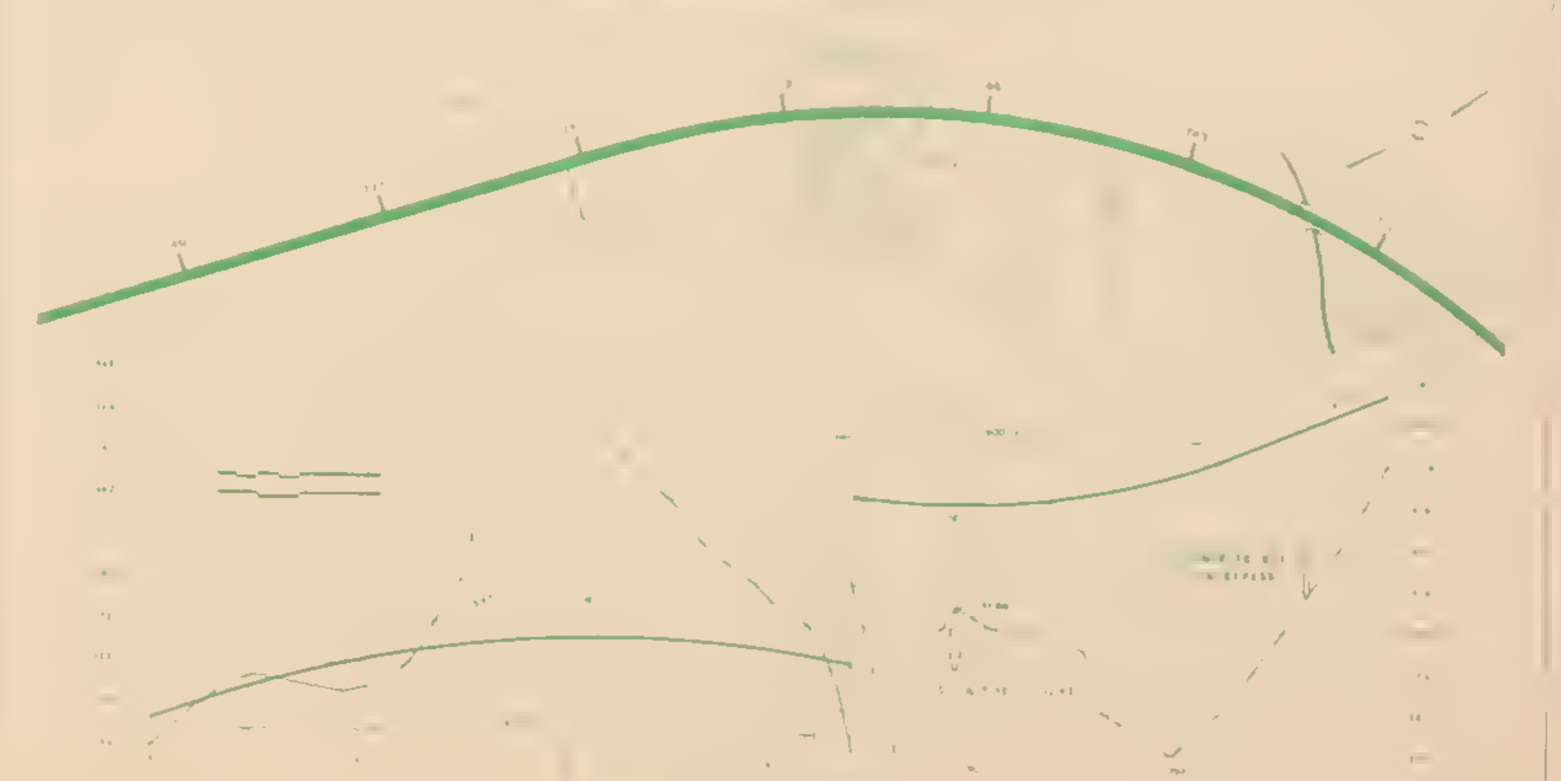
ALTERNATE O EXHIBIT 2



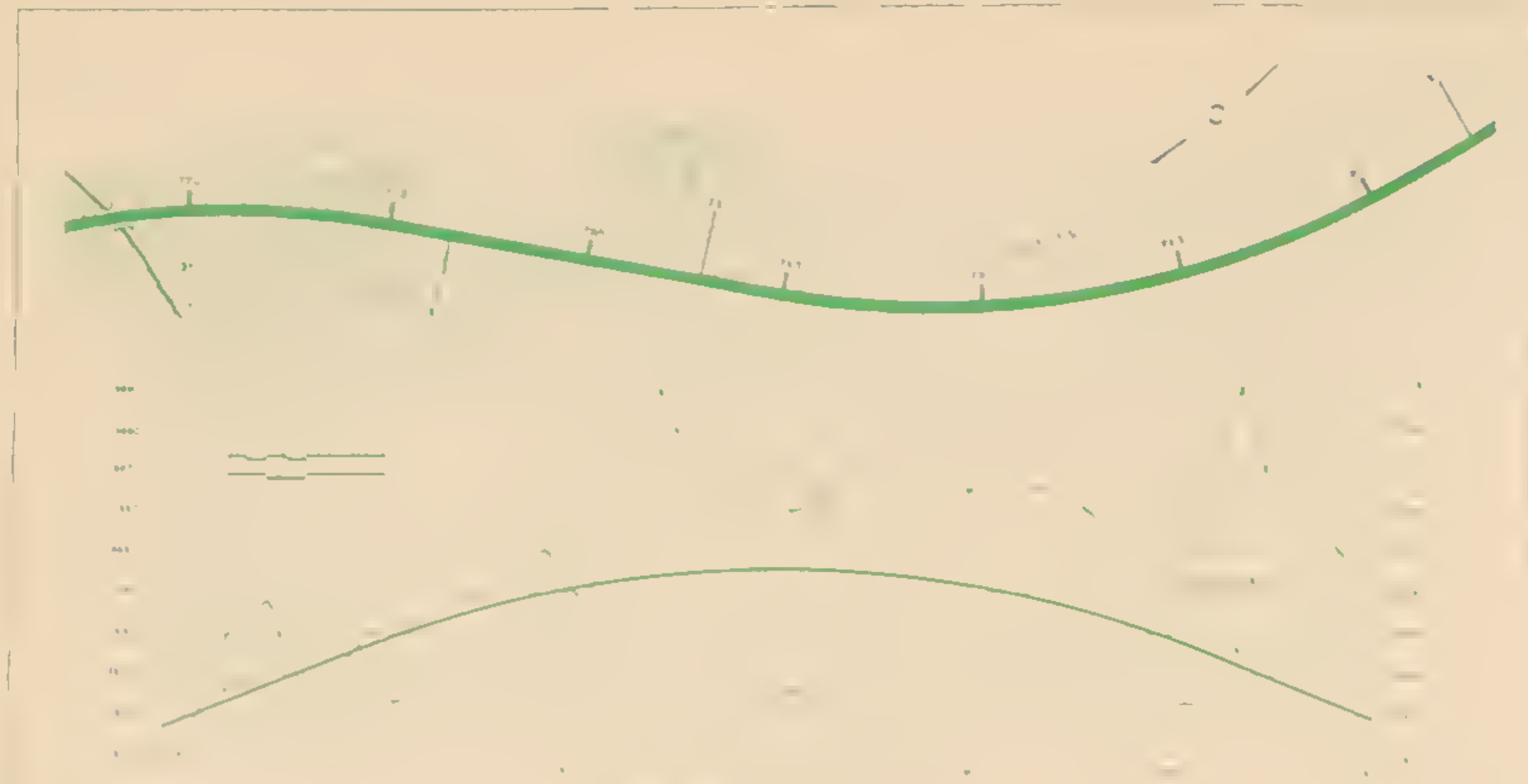
ALTERNATE O EXHIBIT 3



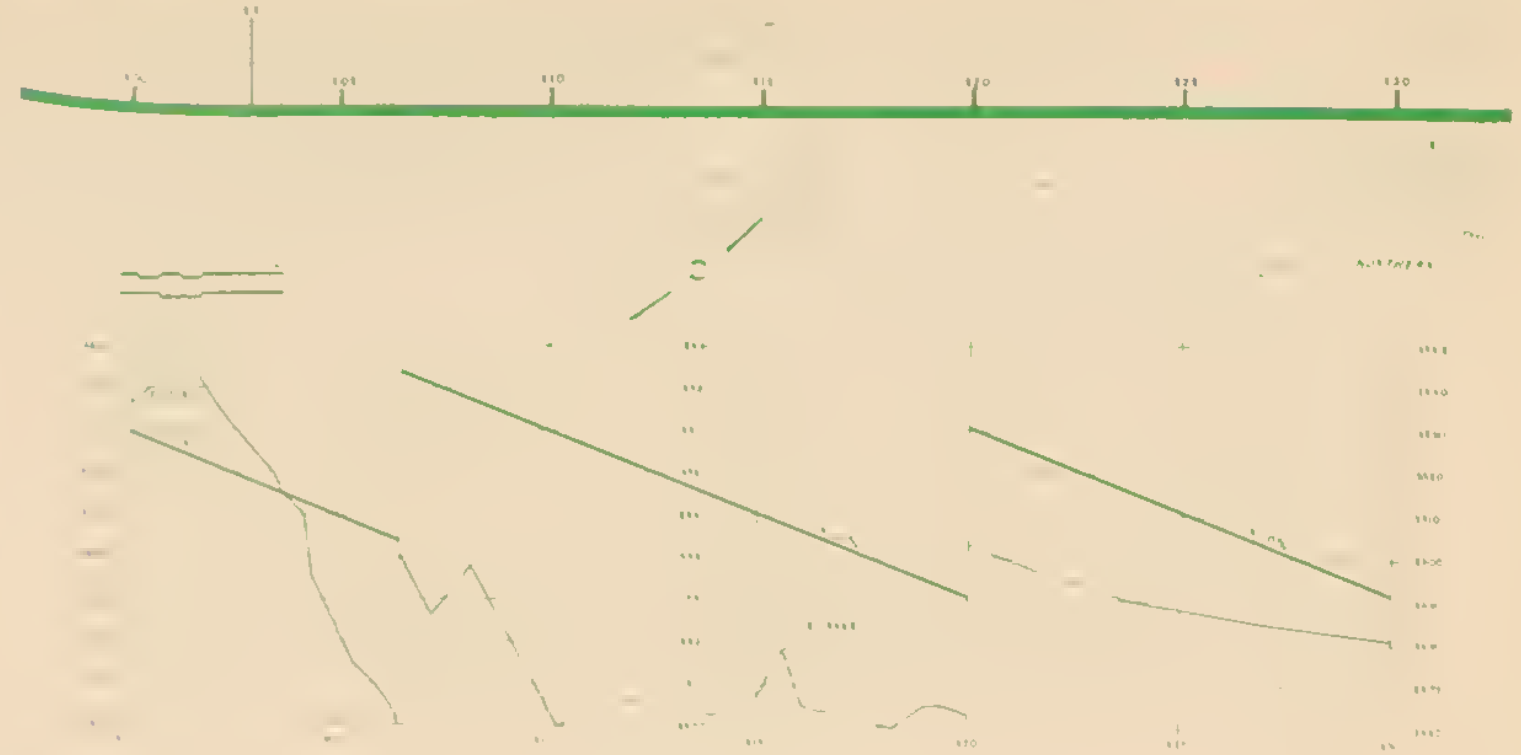
ALTERNATE O EXHIBIT 4



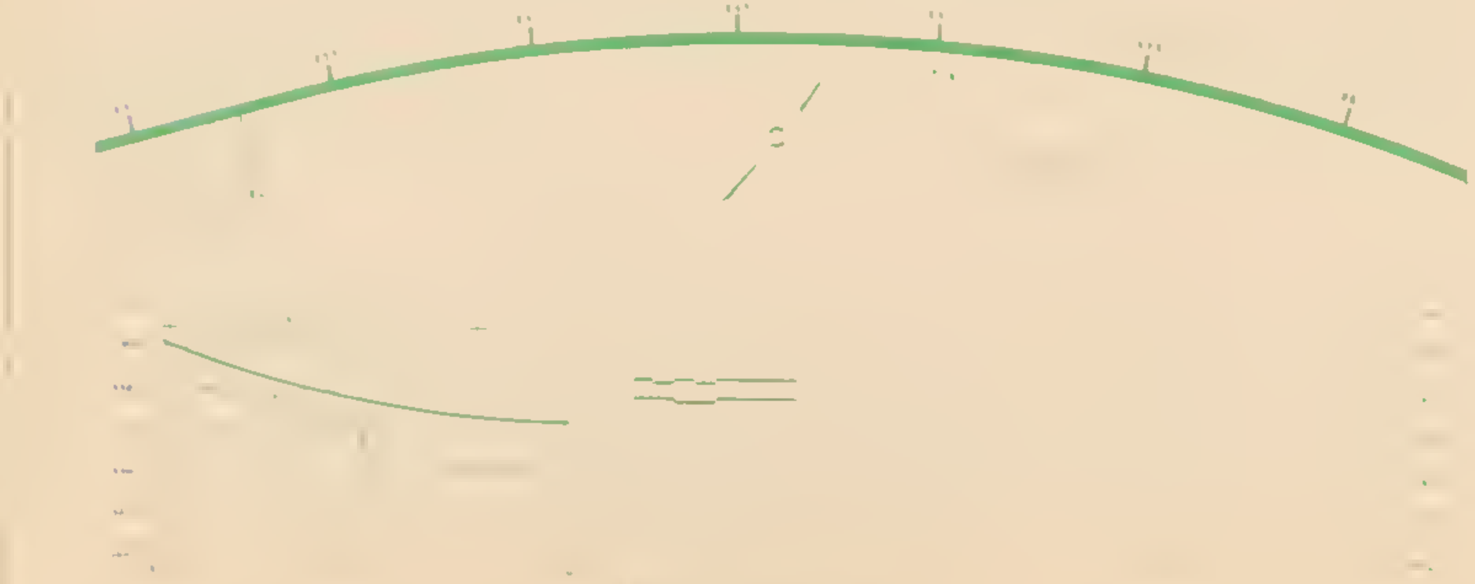
ALTERNATE O EXHIBIT 5



ALTERNATE O EXHIBIT 6



ALTERNATE O EXHIBIT 7



ALTERNATE O EXHIBIT 8

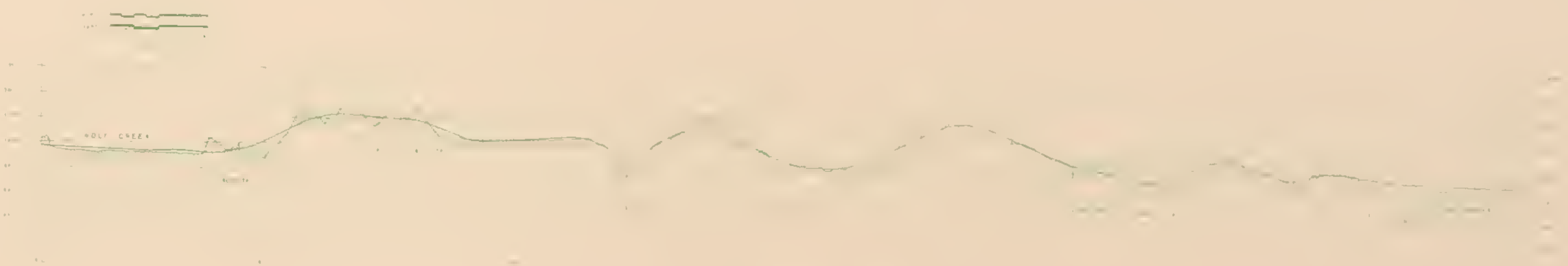
LOCATION ALTERNATE R

1. STATION 537 + 40 TO STATION 576 + 00 SAME AS ALTERNATE M (REFER FIGURES 2 THROUGH 4)
2. STATION 576 + 00 TO STATION 655 + 00 SAME AS ALTERNATE O EXHIBITS 2 THROUGH 5 ON FIGURES 108 AND 109
3. STATION 655 + 00 TO STATION 775 + 00 SAME AS ALTERNATE O EXHIBITS 2 THROUGH 6 ON FIGURES 113 AND 114
4. STATION 775 + 00 TO STATION 800 + 00 EXHIBIT 2 ON FIGURE 115
5. STATION 800 + 00 TO STATION 1159 + 00 SAME AS ALTERNATE M ON FIGURES 11 THROUGH 21

ALTERNATE R EXHIBIT

FIGURE 15

ALTERNATE Y EXHIBIT



PROFILE - ALTERNATE M [illegible] KNEY CREEK

DIVISION 4

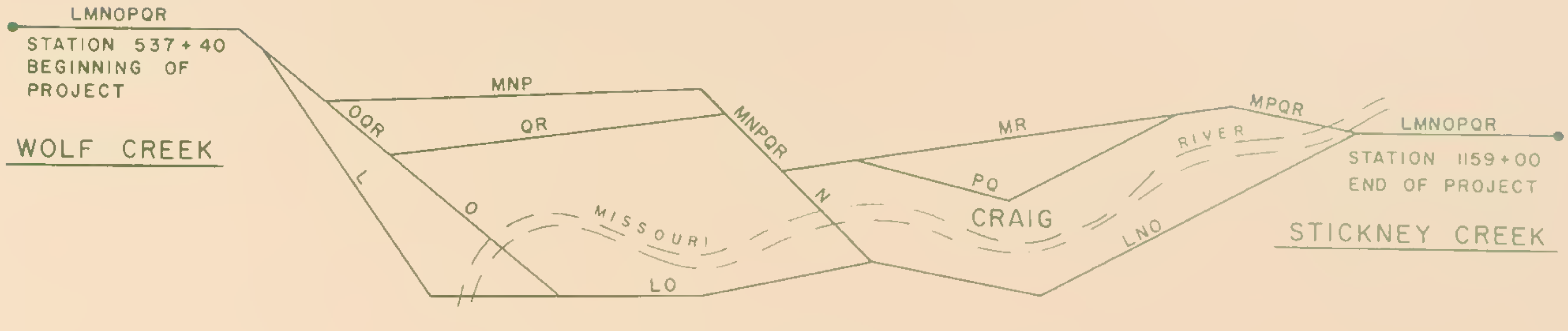
COST ESTIMATES

COST SUMMARY AND COMPARISON OF ALTERNATE LOCATIONS - FIGURE 201
SUMMARY OF PRELIMINARY COST ESTIMATES OF STRUCTURES - FIGURE 202
COST SUMMARY OF CONSTRUCTION SECTIONS - FIGURE 203

FIGURE 20

COST SUMMARY AND COMPARISON OF ALTERNATE LOCATIONS

INTERSTATE 15 - WOLF CREEK TO STICKNEY CREEK



LINE DIAGRAM OF ALTERNATE LOCATIONS

Location	Length Miles	Clearing & Grubbing	Maintenance of Traffic	Earthwork	Retaining Wall	Guard Rail	Surfacing	Small Drainage Structures	Major Structures	Fencing & Signing	Utilities Relocation	Right of Way	Total Cost
L	11.77	$ 8,190	$86,018	$1,697,267	$	$208,051	$1,278,130	$314,793	$1,875,000	$93,344	$52,300	$526,428	$6,110,521
M	10.79	12,484	9,944	2,597,688	165,625	294,510	1,150,990	371,040	1,255,000	97,944	59,000	301,901	6,316,126
N	11.26	14,092	82,038	2,326,571	165,625	228,088	1,023,316	316,292	1,270,000	95,684	55,800	335,485	5,912,991
O	11.55	26,650	82,325	2,048,180	124,825	233,198	1,128,401	266,905	2,015,000	93,920	39,500	330,461	6,389,365
P	11.02	12,484	9,944	2,836,953	165,625	282,255	1,229,388	367,310	1,260,000	98,836	54,600	407,147	6,724,542
Q	11.18	22,514	9,944	3,087,444	124,825	374,655	1,199,805	482,519	1,155,000	98,756	38,100	492,348	7,085,910
R	11.00	22,409	9,944	2,834,740	124,825	369,905	1,136,832	400,049	1,150,000	97,904	42,500	382,573	6,571,681

SUMMARY OF PRELIMINARY COST ESTIMATES OF STRUCTURES

INTERSTATE 15 - WOLF CREEK TO STICKNEY CREEK

STRUCTURE NUMBER AND STATION	STRUCTURE DESCRIPTION	Includes Cost for Pile Foundation	TENTATIVE LAYOUT				ESTIMATED COST FOR LOCATIONS CONSIDERED—DOLLARS						
			WIDTH BTW CURBS	ESTIMATED LENGTH	NO SPANS	TYPE CONSTRUCTION	SELECTED LOCATION	L	N	O	P	Q	R
PE 70 613 + 30	Wolf Creek Interchange Interstate Over Local		68	138'	3	Prestressed Concrete		120,000					
PF 80	Local Road Over RR & Creek	X	28	301'	5	Prestressed Concrete		135,000					
PF 100 732 + 50	Missouri River Interchange Interstate Over River & Local	X	28	710'	7	Built-up Steel		810,000					
PF 150 999 + 60	Craig Interchange Interstate Over Local		44'	115'	5	Prestressed Concrete		65,000	65,000	65,000			
PE 70 1140 + 00	Interstate Over Stickney Creek		44'	133	3	Prestressed Concrete	80,000	80,000	80,000	80,000	80,000	80,000	80,000
PW 25 552 + 00	Interstate Over Creek, RR and Local	X	60'	595	8	WF Steel		590,000					
PW 29	Ramp Over Little Prickly Pear Creek	X	34	112'	2	Prestressed Concrete		75,000					
PW 30 566 + 75	Wolf Creek Interchange Interstate Over Local	X	68	110'	3	Cast-in-Place Concrete	115,000		115,000	115,000	115,000	115,000	115,000
PW 10	Local Road Over Little Prickly Pear Creek	X	36'	80'	1	WF Steel	70,000		70,000	70,000	70,000	70,000	70,000
PW 60 644 + 54	Augusta Interchange Interstate Over Local		72'	138'	3	Prestressed Concrete	135,000		135,000		135,000		

FIGURE 202

SUMMARY OF PRELIMINARY COST ESTIMATES OF STRUCTURES (CONTINUED)

INTERSTATE 15 - WOLF CREEK TO STICKNEY CREEK

STRUCTURE NUMBER AND STATION	STRUCTURE DESCRIPTION	Includes Cost for Pile Foundation	TENTATIVE LAYOUT				ESTIMATED COST FOR LOCATIONS CONSIDERED—DOLLARS						
			WIDTH B/W CURBS	ESTIMATED LENGTH	NO SPANS	TYPE CONSTRUCTION	SELECTED LOCATION	L	N	O	P	Q	R
PW 80 631 + 00	Augusta Interchange Interstate Under Local	X	28'	244'	3	Prestressed Concrete				105,000		105,000	105,000
PW 85 675 + 50	Interstate Over Little Prickly Pear Creek	X	38'	244'	3	Prestressed Concrete				200,000			
PW 90 689 + 30	Interstate Over RR	X	28'	614	10	Prestressed Concrete and WF Steel				530,000			
PW 105 731 + 00	Interstate Under County Road		28'	180'	3	WF Steel	75,000		75,000		75,000		
PW 120 724 + 50	Missouri River Interchange Interstate Over River & Local	X	28'	710'	7	Built-up Steel				850,000			
PW 125 963 + 10	Craig Interchange Interstate Over Local		38'	120'	3	Prestressed Concrete					120,000	120,000	
PW 130 802 + 30	Interstate Over RR	X	55'	214'	3	Prestressed Concrete			170,000				
PW 135 947 + 25	Craig Interchange Interstate Over Local		38'	113'	3	Concrete Prestressed and WF Steel	115,000						115,000
PW 140 813 + 00	Missouri River Interchange Interstate Over River & Local	X	28'	950'	8	Built-up Steel			560,000				
PW 145 1046 + 56	Interstate Over RR.		28'	466'	7	Prestressed Concrete	185,000				185,000	185,000	185,000
PW 155 1060 + 10	Missouri River Interchange Interstate Over River & Local	X	28'	827'	8	Built-up Steel	480,000				480,000	480,000	480,000
						TOTAL ESTIMATED STRUCTURE COST	$1,255,000	$1,875,000	$1,270,000	$2,015,000	$1,260,000	$1,155,000	$1,150,000

FIGURE 203

COST SUMMARY OF CONSTRUCTION SECTIONS

RECOMMENDED LOCATION ALTERNATE M

INTERSTATE 15 - WOLF CREEK TO STICKNEY CREEK

ITEM	UNIT	UNIT COST	Section 1 Structures in Section 2	Section 2 2.313 Miles Sta. 537+40 to Sta. 660+00	Section 3 Structure Over Missouri River	Section 4 Structures in Section 5	Section 5 3.630 Miles Sta. 920+00 to Sta. 1159+00	Section 6 4.845 Miles Sta. 660+00 to Sta. 920+00	Section 7 Surfacing on Sections 5 and 6	TOTAL
Clearing and Grubbing	L. S.	Lump Sum		$ 10,976			$ 923	$ 585		$ 12,484
Maintenance of Traffic	L. S.	Lump Sum		9,944						9,944
Excavation	*	*		733,683			597,103	811,320		2,142,106
Borrow	Cu. Yd.	$0.32		77,362			49,247	103,725		230,334
Overhaul	Mi. Yd.	0.18		39,447			35,889	149,912		225,248
Retaining Wall	Sq. Ft.	5.00		165,625						165,625
Guard Rail Fill Shoulders	L. Ft.	2.50		35,378			40,997	47,180		123,555
Guard Rail Median Barrier	L. Ft.	5.00		84,050			17,405	69,500		170,955
Surfacing	†	†		297,227					$853,763	$ 150,990
Small Drainage Structures	L. S.	Lump Sum		71,894			100,186	198,960		371,040
Major Structures	L. S.	Lump Sum	$320,000		$480,000	$455,000				1,225,000
Fencing and Siging	L. S.	Lump Sum		31,841			42,438	23,665		97,944
Total Construction Cost			$320,000	$1,557,427	$480,000	$455,000	$884,188	$1,404,847	$853,763	$5,955,225
Construction Engineering Contingencies			32,000	155,743	48,000	45,000	88,119	140,485	85,376	595,523
Utility Relocations				49,000			1,000	9,000		59,000
Right of Way				170,557			72,673	58,671		301,901
Total Cost			$352,000	$1,932,727	$528,000	$500,500	$1,046,280	$1,613,003	$939,139	$6,911,649

*Unit Cost per yard of excavation varies from $0.32 to $1.25 proportionately with the percentage and nature of rock encountered.

Unit Cost per station varies from $1,180.00 for 2-lane highway, to $2,260.00 for 4-lane highway. Cost also varies with section depth; See typical sections.